



## Mark Scheme (Results)

October 2023

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

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## 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: <ul style="list-style-type: none"> <li>ammonia (gas) / <math>\text{NH}_3</math> ((g))</li> </ul>	Do not award $\text{NH}_4^+$ / ammonium ion	(1)

Question Number	Answer	Additional Guidance	Mark
1(a)(ii)	An answer that makes reference to the following point: <ul style="list-style-type: none"> <li><math>\text{NH}_4^+</math></li> </ul>	Ignore ammonium Do not award ammonia/ $\text{NH}_3$ / $\text{NH}_4$	(1)

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>(with sodium hydroxide) deprotonation / removal of a proton</li> <li>(with ammonia) ligand exchange (is taking place)</li> </ul>	<p>(1) Allow the hydroxide precipitate is showing amphoteric (behaviour) Allow neutralisation Allow acid/base</p> <p>(1) Allow ligand substitution Do not award deprotonation <b>and</b> ligand exchange</p> <p>Ignore any equations even if incorrect</p>	(2)

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	An answer that makes reference to the following point: <ul style="list-style-type: none"> <li>• <math>\text{Cr}^{3+}</math></li> </ul>	Allow chromium (III) Allow $\text{Cr}(\text{H}_2\text{O})_6^{3+}$	(1)

Question Number	Answer	Additional Guidance	Mark
1(c)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> <li>• <math>\text{SO}_4^{2-}</math></li> </ul>	Ignore sulfate	(1)

Question Number	Answer	Additional Guidance	Mark
1(c)(ii)	An answer that makes reference to the following point: <ul style="list-style-type: none"> <li>• (the hydrochloric acid) reacts with/ removes/eliminates other ions that may give a precipitate (with barium chloride)</li> </ul>	Allow (the hydrochloric acid) reacts with/removes/eliminates carbonate (ions) / $\text{CO}_3^{2-}$ / hydrogencarbonate (ions) / $\text{HCO}_3^-$ Allow sulfate(IV) / sulfite (ions) / $\text{SO}_3^{2-}$ Allow Ignore to dissolve the barium chloride If name and formula are given both must be correct	(1)

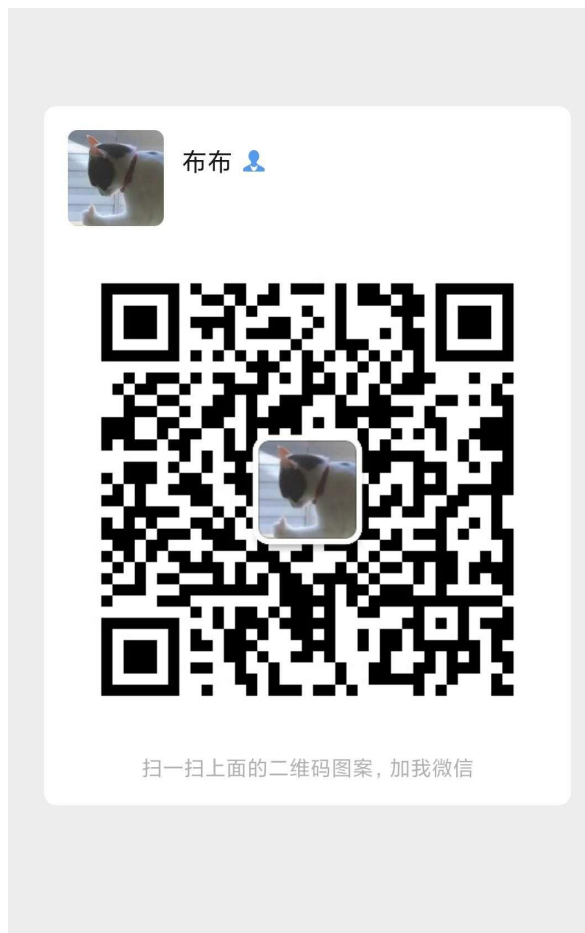
Question Number	Answer	Additional Guidance	Mark
1(d)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>• <math>\text{NH}_4\text{Cr}(\text{SO}_4)_2</math></li> </ul>	<p>Allow TE on (a)(ii), (b)(ii) and (c)(i) even if the ions are wrong</p> <p>Do not award any TE formula containing one anion and one cation</p> <p>Do not award any TE formula that is charged</p> <p>Do not award any TE formula with 2 anions and 1 cation</p>	(1)

(Total for Question 1 = 8 marks)

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Question Number	Answer	Additional Guidance	Mark
2(a)	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>• Ketone</li> <li>• carboxylic acid</li> </ul>	<p>(1) Ignore carbonyl Ignore the type of ketone e.g. methylketone will score</p> <p>(1) Allow just carboxyl Allow just carboxylic Allow near miss spellings Ignore COOH etc</p>	(2)

Question Number	Answer	Additional Guidance	Mark
2(b)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> <li>• bubbles / effervescence</li> </ul>	<p>Allow fizzing Ignore colourless gas given off / CO<sub>2</sub> given off Do not award any reference to misty fumes Do not award bubbles <b>and</b> white ppt</p>	(1)

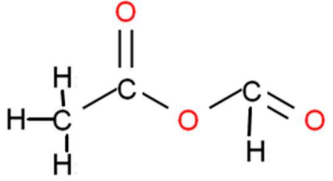
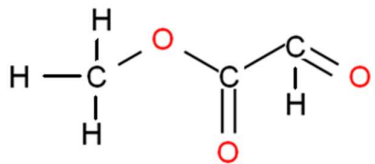
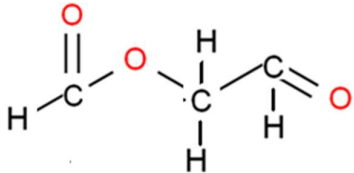
Question Number	Answer	Additional Guidance	Mark						
2(b)(ii)	An answer that makes reference to the following points: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th colspan="2">Observations</th> </tr> <tr> <th>Initial colour</th> <th>Final colour</th> </tr> </thead> <tbody> <tr> <td>orange (solution)</td> <td>orange (solution)</td> </tr> </tbody> </table>	Observations		Initial colour	Final colour	orange (solution)	orange (solution)	<p>Allow no change for final colour Allow no observation</p>	(1)
Observations									
Initial colour	Final colour								
orange (solution)	orange (solution)								



Question Number	Answer	Additional Guidance	Mark
2(b)(iii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>yellow / orange / red <b>and</b> precipitate</li> </ul>	Allow ppte / ppt / solid / crystals Allow near miss spellings  Do not award brick red	(1)

Question Number	Answer	Additional Guidance	Mark						
2(b)(iv)	An answer that makes reference to the following points: <table border="1" style="margin-left: 40px;"> <thead> <tr> <th colspan="2">Observations</th> </tr> <tr> <th>Initial appearance</th> <th>Final appearance</th> </tr> </thead> <tbody> <tr> <td>blue (solution)</td> <td>blue (solution)</td> </tr> </tbody> </table>	Observations		Initial appearance	Final appearance	blue (solution)	blue (solution)	Allow no change for final appearance Allow no observation Ignore shades of colour eg deep blue Do not award blue precipitate/solid	(1)
Observations									
Initial appearance	Final appearance								
blue (solution)	blue (solution)								

Question Number	Answer	Additional Guidance	Mark
2(b)(v)	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>(pale) yellow <b>and</b> precipitate</li> </ul>	Allow ppte / ppt / solid / crystals Allow near miss spellings  Allow just antiseptic smell	(1)

Question Number	Answer	Additional Guidance	Mark
2(c)	<p>An answer that makes reference to the following points:</p> <p>Any non-cyclic, saturated molecule that contains</p> <ul style="list-style-type: none"> <li>• an aldehyde group</li> <li>• an ester group</li> </ul>	<p>Examples include</p> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="margin-right: 10px;">(1)</div>  </div> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="margin-right: 10px;">(1)</div>  </div>  <p>Allow skeletal / structural formulae or combination</p> <p>If the structure contains an obvious error e.g. a pentavalent C, max 1</p> <p>If the structure is not C<sub>3</sub>H<sub>4</sub>O<sub>3</sub> max 1</p>	(2)

(Total for Question 2 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
3(a)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• ethanedioic acid is soluble in water or not very soluble in hexane</li> <li>• because ethanedioic acid can form hydrogen bonds (in water) or ethanedioic acid is a polar molecule <b>and</b> so it dissolves in polar solvents (such as water) or ethanedioic acid is a polar molecule <b>and</b> so is insoluble in a non-polar solvent (such as hexane)</li> </ul>	<p>(1) Allow ethanedioic acid dissolves better in water Allow insoluble/does not dissolve in hexane</p> <p>(1) Ignore any other types of intermolecular force</p> <p>If no other mark is scored allow (1) for discussion of the flammability of hexane</p>	(2)

Question Number	Answer	Additional Guidance	Mark
3(b)(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• (sodium hydroxide will require the indicator) phenolphthalein</li> <li>• at the end-point the colour change will be from colourless to pink</li> <li>• (the cerium titration is self-indicating and) at the end-point the colour change will be from colourless to yellow</li> </ul>	<p>(1) Allow other indicators eg Methyl orange from red to orange scores M1 and M2 Do not award litmus/universal indicator</p> <p>(1) Both colours required Allow red M2 dependent on M1</p> <p>(1) Allow just solution becomes yellow Ignore any reference to bubbles being formed</p> <p>Note Allow one mark for both colour changes reversed.</p> <p>Phenolphthalein pink to colourless and yellow to colourless for the cerium titration scores 1</p> <p>Methyl orange yellow to orange and yellow to colourless for the cerium titration scores 1</p>	(3)

Question Number	Answer	Additional Guidance	Mark
3(b)(ii)	<ul style="list-style-type: none"> <li>• moles of NaOH in the mean titre</li> <li>• moles (COOH)<sub>2</sub> in 25.0 cm<sup>3</sup> of solution</li> <li>• moles (COOH)<sub>2</sub> in 1000.0 cm<sup>3</sup></li> <li>• mass (COOH)<sub>2</sub> in 1000.0 cm<sup>3</sup></li> <li>• calculation of % by mass <b>and</b> answer to 2 or 3 SF</li> </ul>	<p>Example of calculation</p> <p>(1) <math>20.60 \times 0.0400 \div 1000 = 0.000824 / 8.24 \times 10^{-4}</math> (mol)</p> <p>(1) <math>8.24 \times 10^{-4} \div 2 = 4.12 \times 10^{-4} / 0.000412</math> (mol)</p> <p>(1) <math>4.12 \times 10^{-4} \times 40 = 1.648 \times 10^{-2} / 0.01648</math> (mol)</p> <p>(1) <math>0.01648 \times 90 = 1.4832</math> (g)</p> <p><math>100 \times 1.4832 \div 319 = 0.46495</math></p> <p>(1) 0.46% / 0.465%</p> <p>Allow 0.47%</p> <p>TE throughout unless percentage greater than 100%</p> <p>Correct answer with or without working scores 5</p>	(5)

Question Number	Answer	Additional Guidance	Mark
3(c)	<ul style="list-style-type: none"> <li>• moles of (COOH)<sub>2</sub> (1)</li> <li>• calculation of molar mass (1)</li> <li>• calculation of x (1)</li> </ul>	<p>Example of calculation</p> <p><math>500 \times 0.5 \div 1000 = 0.25</math> (mol)</p> <p><math>31.5 \div 0.25 = 126</math> (g mol<sup>-1</sup>)</p> <p><math>126 - 90</math></p> <p><math>36 \div 18 = 2</math></p> <p>Or</p> <p><math>500 \times 0.5 \div 1000 = 0.25</math> (mol)</p> <p><math>0.25 \times 90 = 22.5</math> and <math>31.5 - 22.5 = 9</math></p> <p><math>9 \div 18 = 0.5</math> and <math>0.25 : 0.5 = 2</math></p> <p>Allow TE except for wrong molar mass of water</p> <p>Correct answer with <b>some</b> working scores 3</p>	(3)

(Total for Question 3 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• corrosive <b>and</b> oxidising (agent)</li> </ul>	<p>Ignore skin irritant</p> <p>Allow oxidant/ oxidizer</p> <p>Allow oxidising agent that causes flammability</p> <p>Ignore order</p> <p>Do not award oxidative</p> <p>Do not award oxidable</p> <p>Do not award combustion adjuvant</p> <p>Do not award flammable</p>	<b>(1)</b>

Question Number	Answer	Additional Guidance	Mark
4(a)(ii)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>• (wear) gloves</li> </ul>	<p>Allow keep away from flammable substances</p> <p>Ignore use it in a fume cupboard/open space</p> <p>Ignore use a small quantity</p> <p>Ignore use tongs</p>	<b>(1)</b>

Question Number	Answer	Additional Guidance	Mark
4(b)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>the reaction is (highly) <b>exothermic</b></li> <li>(if the temperature gets too hot) other reactions may take place / multiple substitutions may take place / multiple nitration may take place/the ester may be hydrolysed</li> </ul>	<p>(1) Ignore mixture gets hot/ (heat) energy given off/ heat is produced Comment: the question implies that the reaction gets hot so M1 is only for exothermic</p> <p>(1) Allow mixture will boil <b>and</b> reactants will be lost Allow reactants will evaporate Allow other products may be formed</p> <p>Ignore products will evaporate Ignore splash / spray /spill/spit Ignore to keep the temperature below 7°C/ low Ignore prevents decomposition Ignore violent reaction</p> <p>Do not award phenol may be formed</p>	(2)

Question Number	Answer	Additional Guidance	Mark
4(c)(i)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>solid / methyl 3-nitrobenzoate is (very) soluble at high temperatures (in methanol) but less soluble / insoluble at low temperatures</li> </ul>	<p>Allow the solubility of methyl 3-nitrobenzoate (in methanol) varies with temperature Ignore any reference to water</p>	(1)



Question Number	Answer	Additional Guidance	Mark
4(c)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>the first/hot filtration removes/ separates the insoluble impurities</li> <li>the second/cooled filtration removes/separates the soluble impurities</li> </ul>	<p>(1) Ignore removes solid impurities</p> <p>(1) Remove the insoluble and soluble impurities scores 2 as this is the order the filtrations are done in</p> <p>Remove the soluble and insoluble impurities scores 1 as this is not the order the filtrations are done in</p> <p>Just removes impurities score 0</p>	(2)

Question Number	Answer	Additional Guidance	Mark
4(c)(iii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>to wash off (soluble) impurities (on the crystals of methyl 3-nitrobenzoate)</li> <li>ice-cold so that the crystals do not dissolve</li> </ul>	<p>(1) Allow to wash so there are no other compounds on the crystals Allow to remove (soluble) impurities (on the crystals of methyl 3-nitrobenzoate)</p> <p>Ignore just to clean the crystal Ignore so the crystals are pure Do not award to remove the insoluble impurities</p> <p>(1) Ignore to obtain more crystals/increase yield</p>	(2)

Question Number	Answer	Additional Guidance	Mark
4(d)(i)	<ul style="list-style-type: none"> <li>• moles of methyl benzoate and mass of methyl 3-nitrobenzoate</li>   <li>• % yield calculation</li> </ul> <p>Or</p> <ul style="list-style-type: none"> <li>• moles of methyl benzoate and moles of methyl 3-nitrobenzoate</li>   <li>• % yield calculation</li> </ul>	<p>Example of calculation</p> <p>(1) <math>1.95 \div 136 = 0.014338</math> (mol)  <math>0.01434 \times 181 = 2.5952</math> (g)</p> <p>(1) <math>100 \times 1.51 \div 2.595 = 58.184</math> %</p> <p>(1) <math>1.95 \div 136 = 0.014338</math> (mol)  <math>1.51 \div 181 = 0.0083425</math></p> <p>(1) <math>100 \times 0.0083425 \div 0.014338 = 58.184</math> %</p> <p>Ignore SF except 1SF in final answer  Ignore rounding/ truncating errors except in the final answer</p> <p>Correct answer with or without workings scores 2</p>	(2)

Question Number	Answer	Additional Guidance	Mark
4(d)(ii)	<p>An answer that makes reference to one of the following points:</p> <ul style="list-style-type: none"> <li>• side reactions</li> <li>• dinitration / multiple nitrations/ substitutions</li> <li>• incomplete reaction</li> <li>• loss when transferring from the conical flask to the beaker</li> <li>• loss during recrystallisation</li> <li>• some product remains in solution</li> </ul>	<p>Ignore just transfer loss  Ignore impure methyl benzoate/starting material may not be pure   Do not award crystals are not dry</p>	(1)

(Total for Question 4 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
5(a)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• to react with the iodine formed</li> <li>• so a colour change occurs when a certain amount of reaction has taken place</li> </ul>	<p>(1) Allow to remove the iodine Allow to reduce the iodine (to iodide ions) Allow balanced equation</p> <p>(1) Allow to delay the colour change / solution turning blue-black Allow so the solution does not immediately change colour</p> <p>Allow when all the sodium thiosulfate is used up the iodine reacts with the starch/ there is a colour change (2)</p> <p>Do not award to slow down the reaction</p>	(2)

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	<ul style="list-style-type: none"> <li data-bbox="338 277 905 342">• suitable axes and labels with units (1) Axes wrong way round lose M1</li> <li data-bbox="338 383 905 448">• points plotted correctly within half a square (1)</li> <li data-bbox="338 488 905 618">• points joined with a straight line through the origin/would hit the origin if the line was extended. (1) Allow +/- two squares</li> </ul>	<p data-bbox="936 272 1766 305">The points plotted must cover at least half the grid in both directions</p>	(3)

Question Number	Answer	Additional Guidance	Mark
5(b)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• first order with respect to iodide ions</li> <li>• because graph is a straight line through the origin</li> </ul>	<p>(1)</p> <p>(1)</p> <p>Allow the graph (of rate and concentration) is a straight line/ linear  Allow rate is proportional to concentration/volume  Allow 1/t is proportional to concentration /volume  Allow the relationship between two points  Allow constant gradient</p>	(2)

Question Number	Answer	Additional Guidance	Mark
5(c)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>• (the concentrations of hydrogen peroxide and sulfuric acid are effectively constant) so the rate is only dependent on the iodide ions/KI</li> </ul>	<p>Allow they (hydrogen peroxide and sulfuric acid) do not affect the rate</p> <p>Ignore iodide ions are the only variable/only the concentration of iodide ions is changing</p>	(1)

**(Total for Question 5 = 8 marks)**

**(Total for Paper = 50 marks)**

