



# Mark Scheme (Results)

January 2021

Pearson Edexcel International Advanced Level  
In Chemistry (WCH16)  
Paper 1 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.

| Question number | Answer                                                                                                                     | Additional Guidance                                                                                           | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------|
| 1(a)(i)         | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>corrosive</li> </ul> | <p>Allow corrosive and acidic</p> <p>Do not award flammable, harmful, irritant, oxidising, oxidant, toxic</p> | (1)  |

| Question number | Answer                                                                                                                                                                           | Additional Guidance                                                                                                                                                                                                                                                                                                                                       | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1(a)(ii)        | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>drop by drop (1)</li> <li>(dropping) pipette / teat pipette (1)</li> </ul> | <p>Use of a beaker / conical flask to add A will score (0)</p> <p>M1 dependent on apparatus which produces drops e.g burette, syringe</p> <p>Allow dropwise / add in drops</p> <p>Do not award add in small amounts</p> <p>Allow burette</p> <p>Do not award pipette with a stated volume such as 5 cm<sup>3</sup></p> <p>Do not award just ‘dropper’</p> | (2)  |

| Question number | Answer                                                                                                                                                                                           | Additional Guidance                                                                                                                              | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1(b)(i)         | <p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li><math>\text{Cu}_{(\text{aq})}^{2+} / \text{Cu}(\text{H}_2\text{O})_6^{2+}</math></li> </ul> | <p>Allow Copper(II) ions / hexaquacopper(II)<br/>Do not award <math>\text{Cr}^{2+} / \text{Cr}^{3+} / \text{Co}^{2+} / \text{Ca}^{2+}</math></p> | (1)  |

| Question number | Answer                                                                                                                                                              | Additional Guidance | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|
| 1(b)(ii)        | <p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>carbon dioxide / <math>\text{CO}_2(\text{g})</math></li> </ul> |                     | (1)  |

| Question number | Answer                                                                                                                                                                                                                   | Additional Guidance                                       | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|------|
| 1(b)(iii)       | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>carbonate (ion) / <math>\text{CO}_3^{2-}</math> / hydrogencarbonate (ion) / <math>\text{HCO}_3^-</math></li> </ul> | <p>If name and formula are given both must be correct</p> | (1)  |

| Question number | Answer                                                                                                                                                                                                                                                                                           | Additional Guidance                                                                                                                                                                                                     | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1(b)(iv)        | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>(conc) hydrochloric acid / <math>\text{HCl}(\text{aq})</math> (1)</li> <li>(in (b)(i)) the yellow colour is due to <math>\text{CuCl}_4^{2-}</math> / tetrachlorocuprate(II) (1)</li> </ul> | <p>Ignore references to carbonate for HCl<br/>Ignore dilute</p> <p>Allow green<br/>Allow tetrachlorocopper ion / complex</p> <p>If no other mark is scored allow (1) for any acid justified with the carbonate test</p> | (2)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                               | Additional Guidance                                                                                                                                                                        | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1(b)(v)         | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>(B) contains a sulfate ion / <math>\text{SO}_4^{2-}</math> / <math>\text{CuSO}_4(\text{aq})</math> / copper(II) sulphate (1)</li> <li>(D) is barium chloride (solution) / <math>\text{BaCl}_2(\text{aq})</math> (1)</li> </ul> | <p>Do not award other compounds containing sulfate ions</p> <p>Allow barium nitrate / <math>\text{Ba}(\text{NO}_3)_2</math> / Lead(II) nitrate / <math>\text{Pb}(\text{NO}_3)_2</math></p> | (2)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Additional Guidance                                                            | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------|
| 1(b)(vi)        | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>Copper(II) hydroxide / <math>\text{Cu}(\text{OH})_2(\text{s})</math> / <math>\text{Cu}(\text{OH})_2(\text{H}_2\text{O})_4(\text{s})</math> (1)</li> <li>Tetraamminecopper(II) / Tetraamminediaquacopper(II) / <math>[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}(\text{aq})</math> / <math>[\text{Cu}(\text{NH}_3)_4]^{2+}(\text{aq})</math> (1)</li> </ul> | Do not award $[\text{Cu}(\text{NH}_3)_6]^{2+}(\text{aq})$ / hexaminecopper(II) | (2)  |

| Question number | Answer                                                                                                                                                                                                                      | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1(b)(vii)       | <ul style="list-style-type: none"> <li><math>[\text{CuEDTA}]^{2-}</math> / <math>\text{CuEDTA}^{2-}</math> / <math>\text{Na}_2[\text{CuEDTA}]</math> as a product (1)</li> <li>remainder of equation correct (1)</li> </ul> | <p>Example of equation</p> <p>Allow equations using different starting complex ions or ions such as <math>[\text{Cu}(\text{NH}_3)_6]^{2+}</math> / <math>[\text{Cr}(\text{NH}_3)_6]^{2+}</math> / <math>\text{Cr}^{2+}</math> / <math>[\text{Cr}(\text{NH}_3)_6]^{3+}</math> / <math>\text{Cr}^{3+}</math> / <math>[\text{Cr}(\text{NH}_3)_4]^{2+}</math> applying TE to the formula and charge of the EDTA complex formed as a product.</p> <p><math>\text{Cu}^{2+} + \text{EDTA}^{4-} \rightarrow \text{CuEDTA}^{2-}</math><br/> or<br/> <math>\text{Cu}^{2+} + \text{Na}_4\text{EDTA} \rightarrow \text{CuEDTA}^{2-} + 4\text{Na}^+</math><br/> or<br/> <math>[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+} + \text{Na}_4\text{EDTA} \rightarrow [\text{CuEDTA}]^{2-} + 4\text{Na}^+ + 4\text{NH}_3 + 2\text{H}_2\text{O}</math><br/> or<br/> <math>[\text{Cu}(\text{NH}_3)_4]^{2+} + \text{EDTA}^{4-} \rightarrow [\text{CuEDTA}]^{2-} + 4\text{NH}_3</math></p> <p>Ignore state symbols even if incorrect</p> | (2)  |

(Total for Question 1 = 14 marks)

| Question number | Answer                                                                                                                                                                                | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2(a)            | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• SO<sub>2</sub> is toxic / corrosive</li> <li>• use a fume cupboard</li> </ul> | <p>Assume 'it' is the reaction mixture not specifically SO<sub>2</sub></p> <p>(1) Allow just 'SO<sub>2</sub> (is the main hazard)'<br/>Allow SO<sub>2</sub> is poisonous<br/>Ignore pungent/unpleasant smell</p> <p>(1) Dependant on an appropriate hazard being suggested.<br/>Allow a well ventilated laboratory<br/>Ignore mask<br/>Do not award just 'fume cupboard' with no hazard given</p> <p>If M1 is not scored allow M2 for a suitable safety precaution for a stated hazard <b>not</b> associated with SO<sub>2</sub><br/>e.g. potassium chlorate(V) is corrosive so wear gloves would score M2<br/>If M1 is scored for just 'SO<sub>2</sub> is the main hazard' do not award M2<br/>If more than one hazard is stated do not allow M1 but allow M2 if one of the hazards has a suitable precaution</p> | (2)  |

| Question number | Answer                                                                                                                                                                                         | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                          | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2(b)            | <ul style="list-style-type: none"> <li>calculation of the number of moles of silver chloride formed (1)</li> <li>calculation of the concentration of <math>\text{KClO}_3</math> (1)</li> </ul> | <p><u>Example of calculation</u></p> <p><math>= 0.430 \div 143.4 = 0.0029986 / 2.9986 \times 10^{-3} \text{ (mol)}</math></p> <p><math>= \text{answer to M1} \times 10</math></p> <p><math>= 0.0029986 \times 10 = 0.029986 / 2.9986 \times 10^{-2} / 0.0300 \text{ (mol dm}^{-3}\text{)}</math></p> <p>Allow TE</p> <p>Do not award incorrect units on the final answer</p> <p>Ignore SF including 1 SF</p> | (2)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2(c)            | <p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>silver nitrate/silver nitrate solution is present (because the precipitate is not washed) (1)</li> <li>(so added mass of silver nitrate/solution) is included in the calculation / mass of AgCl appears higher or (added mass of silver nitrate / solution) means calculated moles of AgCl / moles of KClO<sub>3</sub> is higher (1)</li> </ul> | <p>M2 dependent on the solid containing silver, nitrate solution, water or not being dried properly</p> <p>Allow silver chloride/precipitate is not fully dried<br/>Ignore measurement error</p> <p>Allow water in place of silver nitrate solution<br/>Allow the mass of AgCl obtained was higher</p> <p>Do not award just 'so concentration of KClO<sub>3</sub> is higher'<br/>Do not award just 'mass of AgCl is larger' without a source for the extra mass</p> <p>If M1 is not scored allow one mark for a description of higher calculated mass or moles from other error such as impurities</p> | (2)  |

| Question number | Answer                                                                                                                                          | Additional Guidance                                                                                                                                                                                                  | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2(d)            | <p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>from green <b>and</b> to yellow</li> </ul> | <p>Allow green <b>and</b> to yellow-brown / orange / brown</p> <p>Ignore modifiers e.g. pale<br/>Ignore states even if incorrect</p> <p>Do not award red or red in combination with other colours e.g. red-brown</p> | (1)  |

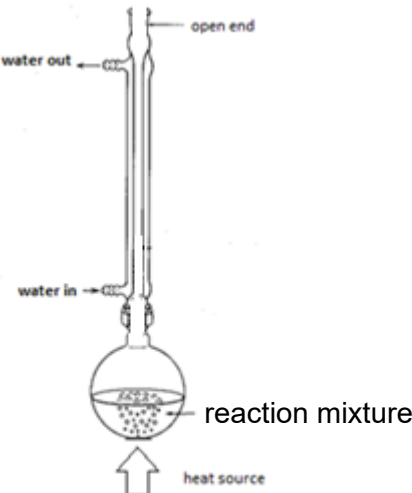
| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                               | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2(e)            | <ul style="list-style-type: none"> <li>potassium manganate(VII) / <math>\text{KMnO}_4</math> solution in a burette (1)</li> <li>add (potassium) manganate(VII) drop by drop (at the end-point) (1)</li> <li>(record the volume when) solution goes (permanent) pink (1)</li> <li>additional two suggestions that would improve accuracy of endpoint (1 mark for each) (2)</li> </ul> | <p>Ignore transfer of reaction solution to a conical flask prior to titration</p> <p>Ignore repeating the experiment and averaging results / doing a rough titration then doing an accurate one using the whole reaction mixture</p> <p>Do not award pipette instead of burette</p> <p>Ignore transfer slowly</p> <p>Ignore initial colour of titration, even if incorrect e.g. from yellow / colourless / pale green / brown to pink all score (1)</p> <p>Do not award purple</p> <p>e.g. use of a white tile (to more clearly see colour change)</p> <p>rinsing sides of reaction vessel with distilled water</p> <p>swirling/stirring/shaking close to the end-point</p> <p>Rinsing burette with <math>\text{KMnO}_4</math> solution</p> <p>Read the bottom of the meniscus at eye-level</p> <p>Addition of (dilute) sulfuric acid (added to <math>\text{Fe}^{2+}</math> or <math>\text{KMnO}_4</math>)</p> <p>Do not award concentrated sulfuric acid</p> <p>If a sample is taken from the whole mixture then max 4</p> <p>If titration is reversed (iron(II) in burette) allow TE max 4</p> | (5)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2(f)            | <ul style="list-style-type: none"> <li>calculation of initial number of moles of <math>\text{Fe}^{2+}</math> (1)</li> <li>calculation of number of moles of potassium manganate(VII) in titration (1)</li> <li>calculation of the number of moles of <math>\text{Fe}^{2+}</math> remaining after the reactions (1)</li> <li>calculation of the number of moles of <math>\text{Fe}^{2+}</math> that have reacted (1)</li> <li>calculation of the number of moles of chlorate ions that have reacted (1)</li> <li>calculation of the concentration of the solution (1)</li> </ul> | <p>Example of calculation:</p> $= \frac{150}{1000} \times 0.0750 = 0.01125 / 1.125 \times 10^{-2} \text{ (mol)}$ <p>(answer 1)</p> $= \frac{9.25}{1000} \times 0.050 = 0.0004625 / 4.625 \times 10^{-4} \text{ (mol)}$ <p>(answer 2)</p> $(\text{answer 2}) \times 5 = 0.0023125 / 2.3125 \times 10^{-3} \text{ (mol)}$ <p>(answer 3)</p> $(\text{answer 1}) - (\text{answer 3}) = 0.01125 - 0.0023125$ $= 0.01125 - 0.0023125 = 0.0089375 / 8.9375 \times 10^{-3} \text{ (mol)}$ <p>(answer 4)</p> $\frac{(\text{answer 4})}{6} = 0.0014895833 / 1.48958 \times 10^{-3} \text{ (mol)}$ <p>(answer 5)</p> $= \text{answer 5} \div 0.050 = 0.0297917 / 2.97917 \times 10^{-2} \text{ (mol dm}^{-3}\text{)}$ <p>Allow TE for each stage<br/>Ignore SF including 1SF<br/>Penalise incorrect units in final mark only<br/>Correct answer with no working scores (0)</p> | (6)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 2(g)            | <p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>potassium manganate(VII) reacts with <b>chloride ions</b> to make chlorine / oxidises <b>chloride ions</b> / is a stronger oxidising agent than <b>chlorine</b><br/><b>or</b><br/><math>\text{Cl}^-</math> is a reducing agent (and reduces manganate(VII) ions) (1)</li> <li>(so the volume of potassium manganate(VII) would increase) and the calculated concentration of potassium chlorate(V) would decrease (1)</li> </ul> | <p>M2 dependent on M1 being scored or an incorrect description of chloride ions / chlorine ions reacting with <math>\text{Fe}^{2+}</math></p> <p>Allow just 'chloride ions will react with manganate(VII) ions'<br/>Ignore reaction of <math>\text{Fe}^{2+}</math> with chloride ions<br/>Do not award 'chlorine ions'</p> <p>Allow increase in calculated excess <math>\text{Fe}^{2+}</math>, decrease in calculated reacted <math>\text{Fe}^{2+}</math> or calculated moles of <math>\text{ClO}_3^-</math>.<br/>If more than one is given, all must be correct</p> | (2)  |

(Total for Question 2 = 20 marks)

| Question number | Answer                                                                                                                                                                                        | Additional Guidance                                                                                                                                                                                 | Mark |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 3(a)(i)         | <p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>so that the volatile / toxic benzene doesn't escape from the reaction mixture</li> </ul> | <p>Must be some mention of benzene</p> <p>Allow the reaction reaches completion / otherwise the reaction would not be complete / to ensure all the benzene reacts</p> <p>Ignore effect on yield</p> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                           | Additional guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 3(a)(ii)        | <ul style="list-style-type: none"> <li>round-bottomed / pear shaped flask containing mixture <b>and</b> heat (1)</li> <li>vertical condenser with water jacket <b>and</b> water flowing in the correct direction (1)</li> <li>no gaps and open condenser and apparatus would work (1)</li> </ul> | <p>Example of diagram:</p>  <p>M1 Allow any indication of heat including an arrow or water bath or electrical heater</p> <p>Do not award conical flask/flask with no liquid in</p> <p>Ignore anti bumping granules</p> <p>M3 Ignore thermometer in the top of the condenser if it does not seal the apparatus or through the side of a two necked flask where it is sealed.</p> <p>Ignore stirrer down condenser</p> <p>Do not award if the condenser and flask are one piece of apparatus</p> <p>Allow just M1 for distillation apparatus</p> | (3)  |

| Question number | Answer                                                                                                                                                                                                                                                                                    | Additional Guidance                                                                                                                                                                                                                                                                                                                                                             | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 3(a)(iii)       | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• reactants are immiscible / form separate layers / do not mix (1)</li> <li>• (the reactants need to be mixed) to ensure enough contact for a reaction to take place (1)</li> </ul> | <p>Allow are not completely miscible<br/>Allow to make the reactants mix</p> <p>Allow so allows a reasonable rate of reaction<br/>Allow so the reactants come into contact<br/>Allow so the reactants are exposed to each other<br/>Allow so reaction can take place effectively<br/>Allow to ensure even heat distribution<br/>Ignore just 'increase the rate of reaction'</p> | (2)  |

| Question number | Answer                                                                                                                                                                                                                                                                               | Additional Guidance                                                                                                                                                                      | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 3(b)            | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• (anhydrous) sodium sulfate / <math>\text{Na}_2\text{SO}_4</math> / magnesium sulfate / <math>\text{MgSO}_4</math> / calcium chloride / <math>\text{CaCl}_2</math></li> </ul> | <p>Allow silica gel</p> <p>If both the name and formula are given both must be correct</p> <p>Do not award anhydrous copper sulfate / anhydrous cobalt chloride / conc sulfuric acid</p> | (1)  |

| Question number | Answer                                                                                                                                                                                                       | Additional Guidance                                                          | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|------|
| 3(c)(i)         | <p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li><math>\text{HNO}_2</math> / nitrous acid is unstable / decomposes (so cannot be transported)</li> </ul> | <p>Ignore difficult to store<br/>Do not award reacts to form nitric acid</p> | (1)  |

| Question number | Answer                                                                                                                                                                                                                                                                                                                                               | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Mark |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 3(c)(ii)        | <p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>below <math>0^\circ\text{C}</math> the reaction is too slow</li> <li>above <math>10^\circ\text{C}</math> the diazonium chloride / compound / ion decomposes / hydrolyses / reacts with water / forms phenol (and nitrogen gas)</li> </ul> | <p>(1) Allow reaction mixture may solidify<br/>Allow less energy for overcoming the activation barrier<br/>Ignore reaction will stop / does not occur<br/>Do not award not enough energy to overcome the activation barrier</p> <p>(1) Allow phenol is formed<br/>Allow the product decomposes<br/>Allow phenylamine reacts to form phenol<br/>Ignore nitrous acid decomposes<br/>Ignore it decomposes<br/>Ignore waste products are formed<br/>Do not award the azo dye / Organol Brown / phenylamine would decompose<br/>Do not award multiple substitutions will occur</p> | (2)  |

| Question number | Answer                                                                                                                                                                                                                                                        | Additional Guidance                                                                          | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------|
| 3(d)(i)         | <p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>(so a lot of the azo dye) does not remain in solution (when it cools)</li> </ul> <p><b>or</b></p> <p>gives a saturated solution (when it has cooled)</p> | <p>Ignore ‘to obtain a concentrated solution’</p> <p>Do not award just to maximize yield</p> | (1)  |

| Question number | Answer                                                                                                                                                                                             | Additional Guidance                                                                                               | Mark |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|------|
| 3(d)(ii)        | <p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>(pre-heated) to prevent (premature) crystallisation (of the azo dye in the funnel)</li> </ul> | <p>Allow to keep the Organol Brown / product / solid in solution</p> <p>Ignore it remains in the liquid state</p> | (1)  |

| Question number | Answer                                                                                                                                                                                                                                | Additional Guidance                                                                                                                                                    | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 3(d)(iii)       | <p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>Step <b>2</b> is to remove <b>insoluble</b> impurities</li> <li>Step <b>3</b> is to remove <b>soluble</b> impurities</li> </ul> | <p>If no other mark is scored just ‘to remove insoluble and soluble impurities’ scores <b>(1)</b></p> <p>Do not award ‘to remove soluble and insoluble impurities’</p> | (2)  |

| Question number | Answer                                                                                                                                           | Additional Guidance                                                                                                                                                                        | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 3(d)(iv)        | <p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>to avoid (thermal) decomposition</li> </ul> | <p>Allow to avoid melting the dye / crystals<br/>           Ignore relative speed of drying<br/>           Do not award to stop it making a solution<br/>           Do not award decay</p> | (1)  |

| Question number | Answer                                                                                                                                    | Additional Guidance                                                                                                                                                                                                                                       | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 3(e)            | <p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>sharp melting temperature</li> </ul> | <p>Allow any indication of a small range (<math>\pm 2^{\circ}\text{C}</math>)<br/>           Ignore melting temperature matching data in a data book<br/>           Ignore impurities make the melting point lower / higher than the literature value</p> | (1)  |

(Total for Question 3 = 16 marks)  
 Total for Paper = 50 marks

