



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)	An answer that makes reference to the following points: <ul style="list-style-type: none"> corrosive 	Allow corrosive and acidic Do not award flammable, harmful, irritant, oxidising, oxidant, toxic	(1)

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

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

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

Question number	Answer	Additional Guidance	Mark
1(b)(iii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> carbonate (ion) / CO_3^{2-} / hydrogencarbonate (ion) / HCO_3^- 	If name and formula are given both must be correct	(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"> (conc) hydrochloric acid / $\text{HCl}(\text{aq})$ (1) (in (b)(i)) the yellow colour is due to CuCl_4^{2-} / tetrachlorocuprate(II) (1) 	<p>Ignore references to carbonate for HCl Ignore dilute</p> <p>Allow green 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"> (B) contains a sulfate ion / SO_4^{2-} / $\text{CuSO}_4(\text{aq})$ / copper(II) sulphate (1) (D) is barium chloride (solution) / $\text{BaCl}_2(\text{aq})$ (1) 	<p>Do not award other compounds containing sulfate ions</p> <p>Allow barium nitrate / $\text{Ba}(\text{NO}_3)_2$ / Lead(II) nitrate / $\text{Pb}(\text{NO}_3)_2$</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"> Copper(II) hydroxide / $\text{Cu}(\text{OH})_2(\text{s})$ / $\text{Cu}(\text{OH})_2(\text{H}_2\text{O})_4(\text{s})$ (1) Tetraamminecopper(II) / Tetraamminediaquacopper(II) / $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}(\text{aq})$ / $[\text{Cu}(\text{NH}_3)_4]^{2+}(\text{aq})$ (1) 	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"> $[\text{CuEDTA}]^{2-}$ / CuEDTA^{2-} / $\text{Na}_2[\text{CuEDTA}]$ as a product (1) remainder of equation correct (1) 	<p>Example of equation</p> <p>Allow equations using different starting complex ions or ions such as $[\text{Cu}(\text{NH}_3)_6]^{2+}$ / $[\text{Cr}(\text{NH}_3)_6]^{3+}$ / Cr^{2+} / $[\text{Cr}(\text{NH}_3)_6]^{3+}$ / Cr^{3+} / $[\text{Cr}(\text{NH}_3)_4]^{2+}$ applying TE to the formula and charge of the EDTA complex formed as a product.</p> <p>$\text{Cu}^{2+} + \text{EDTA}^{4-} \rightarrow \text{CuEDTA}^{2-}$ or $\text{Cu}^{2+} + \text{Na}_4\text{EDTA} \rightarrow \text{CuEDTA}^{2-} + 4\text{Na}^+$ or $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2(\text{aq})]^{2+} + \text{Na}_4\text{EDTA} \rightarrow [\text{CuEDTA}]^{2-} + 4\text{Na}^+ + 4\text{NH}_3 + 2\text{H}_2\text{O}$ or $[\text{Cu}(\text{NH}_3)_4(\text{aq})]^{2+} + \text{EDTA}^{4-} \rightarrow [\text{CuEDTA}]^{2-} + 4\text{NH}_3$</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"> • SO₂ is toxic / corrosive • use a fume cupboard 	<p>Assume 'it' is the reaction mixture not specifically SO₂</p> <p>(1) Allow just 'SO₂ (is the main hazard)' Allow SO₂ is poisonous Ignore pungent/unpleasant smell</p> <p>(1) Dependant on an appropriate hazard being suggested. Allow a well ventilated laboratory Ignore mask 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 not associated with SO₂ e.g. potassium chlorate(V) is corrosive so wear gloves would score M2</p> <p>If M1 is scored for just 'SO₂ is the main hazard' do not award M2</p> <p>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"> • calculation of the number of moles of silver chloride formed (1) • calculation of the concentration of KClO₃ (1) 	<p><u>Example of calculation</u></p> <p>= $0.430 \div 143.4 = 0.0029986 / 2.9986 \times 10^{-3}$ (mol)</p> <p>= answer to M1 x 10</p> <p>= $0.0029986 \times 10 = 0.029986 / 2.9986 \times 10^{-2} / 0.0300$ (mol dm⁻³)</p> <p>Allow TE Do not award incorrect units on the final answer 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"> silver nitrate/silver nitrate solution is present (because the precipitate is not washed) (1) (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 KClO₃ is higher (1) 	<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 Ignore measurement error</p> <p>Allow water in place of silver nitrate solution Allow the mass of AgCl obtained was higher</p> <p>Do not award just 'so concentration of KClO₃ is higher' 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"> from green and to yellow 	<p>Allow green and to yellow-brown / orange / brown</p> <p>Ignore modifiers e.g. pale Ignore states even if incorrect</p> <p>Do not award red or red in combination with other colours e.g. red-brown</p>	(1)

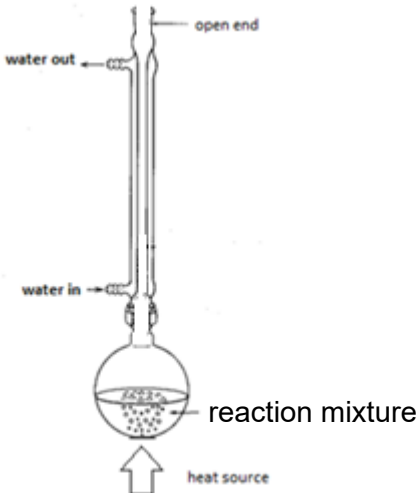
Question number	Answer	Additional Guidance	Mark
2(e)	<ul style="list-style-type: none"> <li data-bbox="421 491 1151 555">• potassium manganate(VII) / KMnO_4 solution in a burette (1) <li data-bbox="421 611 1151 675">• add (potassium) manganate(VII) drop by drop (at the end-point) (1) <li data-bbox="421 730 1151 794">• (record the volume when) solution goes (permanent) pink (1) <li data-bbox="421 914 1151 978">• additional two suggestions that would improve accuracy of endpoint (1 mark for each) (2) 	<p data-bbox="1200 264 1968 328">Ignore transfer of reaction solution to a conical flask prior to titration</p> <p data-bbox="1200 336 1968 440">Ignore repeating the experiment and averaging results / doing a rough titration then doing an accurate one using the whole reaction mixture</p> <p data-bbox="1200 488 1704 520">Do not award pipette instead of burette</p> <p data-bbox="1200 632 1487 663">Ignore transfer slowly</p> <p data-bbox="1200 743 1957 847">Ignore initial colour of titration, even if incorrect e.g. from yellow / colourless / pale green / brown to pink all score (1)</p> <p data-bbox="1200 855 1469 887">Do not award purple</p> <p data-bbox="1200 935 1957 1222">e.g. use of a white tile (to more clearly see colour change) rinsing sides of reaction vessel with distilled water swirling/stirring/shaking close to the end-point Rinsing burette with KMnO_4 solution Read the bottom of the meniscus at eye-level Addition of (dilute) sulfuric acid (added to Fe^{2+} or KMnO_4) Do not award concentrated sulfuric acid If a sample is taken from the whole mixture then max 4</p> <p data-bbox="1200 1262 1957 1294">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 data-bbox="360 341 1111 379">• calculation of initial number of moles of Fe²⁺ (1) <li data-bbox="360 469 1111 539">• calculation of number of moles of potassium manganate(VII) in titration (1) <li data-bbox="360 584 1111 654">• calculation of the number of moles of Fe²⁺ remaining after the reactions (1) <li data-bbox="360 699 1111 769">• calculation of the number of moles of Fe²⁺ that have reacted (1) <li data-bbox="360 906 1111 976">• calculation of the number of moles of chlorate ions that have reacted (1) <li data-bbox="360 1069 1111 1107">• calculation of the concentration of the solution (1) 	<p data-bbox="1144 268 1458 300">Example of calculation:</p> <p data-bbox="1144 341 1783 411">= $\frac{150}{1000} \times 0.0750 = 0.01125 / 1.125 \times 10^{-2}$ (mol) (answer 1)</p> <p data-bbox="1144 453 1783 523">= $\frac{9.25}{1000} \times 0.050 = 0.0004625 / 4.625 \times 10^{-4}$ (mol) (answer 2)</p> <p data-bbox="1144 596 1783 667">(answer 2) $\times 5 = 0.0023125 / 2.3125 \times 10^{-3}$ (mol) (answer 3)</p> <p data-bbox="1144 708 1895 858">(answer 1) – (answer 3) = 0.01125 – 0.0023125 = 0.01125 – 0.0023125 = 0.0089375 / 8.9375 $\times 10^{-3}$ (mol) (answer 4)</p> <p data-bbox="1144 900 1794 970">$\frac{\text{(answer 4)}}{6} = 0.0014895833 / 1.48958 \times 10^{-3}$ (mol) (answer 5)</p> <p data-bbox="1144 1043 1805 1114">= answer 5 $\div 0.050 = 0.0297917 / 2.97917 \times 10^{-2}$ (mol dm⁻³)</p> <p data-bbox="1144 1155 1693 1295">Allow TE for each stage Ignore SF including 1SF Penalise incorrect units in final mark only 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"> potassium manganate(VII) reacts with chloride ions to make chlorine / oxidises chloride ions / is a stronger oxidising agent than chlorine or Cl⁻ is a reducing agent (and reduces manganate(VII) ions) (1) (so the volume of potassium manganate(VII) would increase) and the calculated concentration of potassium chlorate(V) would decrease (1) 	<p>M2 dependent on M1 being scored or an incorrect description of chloride ions / chlorine ions reacting with Fe²⁺</p> <p>Allow just 'chloride ions will react with manganate(VII) ions' Ignore reaction of Fe²⁺ with chloride ions Do not award 'chlorine ions'</p> <p>Allow increase in calculated excess Fe²⁺, decrease in calculated reacted Fe²⁺ or calculated moles of ClO₃⁻. 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"> so that the volatile / toxic benzene doesn't escape from the reaction mixture 	<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 data-bbox="421 938 943 1007">• round-bottomed / pear shaped flask containing mixture and heat (1) <li data-bbox="421 1086 943 1193">• vertical condenser with water jacket and water flowing in the correct direction (1) <li data-bbox="421 1241 943 1310">• no gaps and open condenser and apparatus would work (1) 	<p data-bbox="976 264 1249 296">Example of diagram:</p>  <p data-bbox="976 927 1861 995">M1 Allow any indication of heat including an arrow or water bath or electrical heater</p> <p data-bbox="976 1038 1615 1070">Do not award conical flask/flask with no liquid in</p> <p data-bbox="976 1114 1357 1145">Ignore anti bumping granules</p> <p data-bbox="976 1189 1906 1257">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 data-bbox="976 1262 1368 1294">Ignore stirrer down condenser</p> <p data-bbox="976 1299 1827 1331">Do not award if the condenser and flask are one piece of apparatus</p> <p data-bbox="976 1374 1480 1406">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"> reactants are immiscible / form separate layers / do not mix (1) (the reactants need to be mixed) to ensure enough contact for a reaction to take place (1) 	<p>Allow are not completely miscible Allow to make the reactants mix</p> <p>Allow so allows a reasonable rate of reaction Allow so the reactants come into contact Allow so the reactants are exposed to each other Allow so reaction can take place effectively Allow to ensure even heat distribution 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"> (anhydrous) sodium sulfate / Na_2SO_4 / magnesium sulfate / MgSO_4 / calcium chloride / CaCl_2 	<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"> HNO₂ / nitrous acid is unstable / decomposes (so cannot be transported) 	<p>Ignore difficult to store 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"> below 0°C the reaction is too slow above 10°C the diazonium chloride / compound / ion decomposes / hydrolyses / reacts with water / forms phenol (and nitrogen gas) 	<p>(1) Allow reaction mixture may solidify Allow less energy for overcoming the activation barrier Ignore reaction will stop / does not occur Do not award not enough energy to overcome the activation barrier</p> <p>(1) Allow phenol is formed Allow the product decomposes Allow phenylamine reacts to form phenol Ignore nitrous acid decomposes Ignore it decomposes Ignore waste products are formed Do not award the azo dye / Organol Brown / phenylamine would decompose 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"> (so a lot of the azo dye) does not remain in solution (when it cools) <p>or</p> <ul style="list-style-type: none"> gives a saturated solution (when it has cooled) 	<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"> (pre-heated) to prevent (premature) crystallisation (of the azo dye in the funnel) 	<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"> Step 2 is to remove insoluble impurities (1) Step 3 is to remove soluble impurities (1) 	<p>If no other mark is scored just 'to remove insoluble and soluble impurities' scores (1)</p> <p>Do not award 'to remove soluble and insoluble impurities'</p>	(2)

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

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

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

