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: • 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: • 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 no 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: • $Cu^{2+}_{((aq))}$ / $Cu(H_2O)_6^{2+}$	Allow Copper(II) ions / hexaquacopper(II) Do not award Cr^{2+} / Cr^{3+} / Co^{2+}/ Ca^{2+}	(1)

Question number	Answer	Additional Guidance	Mark
1(b)(ii)	An answer that makes reference to the following point: • carbon dioxide / $CO_2((g))$		(1)

Question number	Answer	Additional Guidance	Mark
1(b)(iii)	An answer that makes reference to the following points: • 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)	An answer that makes reference to the following points: • (conc) hydrochloric acid / HCl((aq)) **(1)** • (in (b)(i)) the yellow colour is due to $CuCl_4^{2-}$ / tetrachlorocuprate(II) **(1)**	Ignore references to carbonate for HCl Ignore dilute Allow green Allow tetrachlorocopper ion / complex If no other mark is scored allow (1) for any acid justified with the carbonate test	**(2)**

Question number	Answer	Additional Guidance	Mark
1(b)(v)	An answer that makes reference to the following points: • (**B**) contains a sulfate ion / SO_4^{2-} / $CuSO_4$((aq)) / copper(II) sulphate **(1)** • (**D**) is barium chloride (solution) / $BaCl_2$((aq)) **(1)**	Do not award other compounds containing sulfate ions Allow barium nitrate / $Ba(NO_3)_2$ / Lead(II) nitrate / $Pb(NO_3)_2$	**(2)**

Question number	Answer	Additional Guidance	Mark
1(b)(vi)	An answer that makes reference to the following points: • Copper(II) hydroxide / $Cu(OH)_2((s))$ / $Cu(OH)_2(H_2O)_4((s))$ **(1)** • Tetraamminecopper(II) / Tetraamminediaquacopper(II) / $[Cu(NH_3)_4(H_2O)_2]^{2+}((aq))$ / $[Cu(NH_3)_4]^{2+}((aq))$ **(1)**	Do not award $[Cu(NH_3)_6]^{2+}((aq))$ / hexaamminecopper(II)	**(2)**

Question number	Answer	Additional Guidance	Mark
1(b)(vii)	• $[CuEDTA]^{2-}$ / $CuEDTA^{2-}$ / $Na_2[CuEDTA]$ as a product **(1)** • remainder of equation correct **(1)**	Example of equation Allow equations using different starting complex ions or ions such as $[Cu(NH_3)_6]^{2+}$/ $[Cr(NH_3)_6]^{2+}$ / Cr^{2+}/ $[Cr(NH_3)_6]^{3+}$ / Cr^{3+}/ $[Cr(NH_3)_4]^{2+}$ applying TE to the formula and charge of the EDTA complex formed as a product. $Cu^{2+} + EDTA^{4-} \rightarrow CuEDTA^{2-}$ or $Cu^{2+} + Na_4EDTA \rightarrow CuEDTA^{2-} + 4Na^+$ or $[Cu(NH_3)_4(H_2O)_2((aq))]^{2+} + Na_4EDTA \rightarrow [CuEDTA]^{2-} + 4Na^+ + 4NH_3 + 2H_2O$ or $[Cu(NH_3)_4((aq))]^{2+} + EDTA^{4-} \rightarrow [CuEDTA]^{2-} + 4NH_3$ Ignore state symbols even if incorrect	**(2)**

(Total for Question 1 = 14 marks)

Question number	Answer	Additional Guidance	Mark
2(a)	An answer that makes reference to the following points: • SO_2 is toxic / corrosive **(1)** • use a fume cupboard **(1)**	Assume 'it' is the reaction mixture not specifically SO_2 Allow just 'SO_2 (is the main hazard)' Allow SO_2 is poisonous Ignore pungent/unpleasant smell Dependant on an appropriate hazard being suggested. Allow a well ventilated laboratory Ignore mask Do not award just 'fume cupboard' with no hazard given If M1 is not scored allow M2 for a suitable safety precaution for a stated hazard **not** associated with SO_2 e.g. potassium chlorate(V) is corrosive so wear gloves would score M2 If M1 is scored for just 'SO_2 is the main hazard' do not award M2 If more than one hazard is stated do not allow M1 but allow M2 if one of the hazards has a suitable precaution	**(2)**

Question number	Answer	Additional Guidance	Mark
2(b)	• calculation of the number of moles of silver chloride formed **(1)** • calculation of the concentration of $KClO_3$ **(1)**	Example of calculation = 0.430 ÷ 143.4 = 0.0029986 / 2.9986 x 10^{-3} (mol) = answer to M1 x 10 = 0.0029986 x 10 = 0.029986 / 2.9986 x 10^{-2} / 0.0300 (mol dm^{-3}) Allow TE Do not award incorrect units on the final answer Ignore SF including 1 SF	**(2)**

Question number	Answer	Additional Guidance	Mark
2(c)	An explanation that makes reference to the following points: • 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 $KClO_3$ is higher **(1)**	M2 dependent on the solid containing silver, nitrate solution, water or not being dried properly Allow silver chloride/precipitate is not fully dried Ignore measurement error Allow water in place of silver nitrate solution Allow the mass of AgCl obtained was higher Do not award just 'so concentration of $KClO_3$ is higher' Do not award just 'mass of AgCl is larger' without a source for the extra mass If M1 is not scored allow one mark for a description of higher calculated mass or moles from other error such as impurities	**(2)**

Question number	Answer	Additional Guidance	Mark
2(d)	An answer that makes reference to the following point: • from green **and** to yellow	Allow green **and** to yellow-brown / orange / brown Ignore modifiers e.g. pale Ignore states even if incorrect Do not award red or red in combination with other colours e.g. red-brown	**(1)**

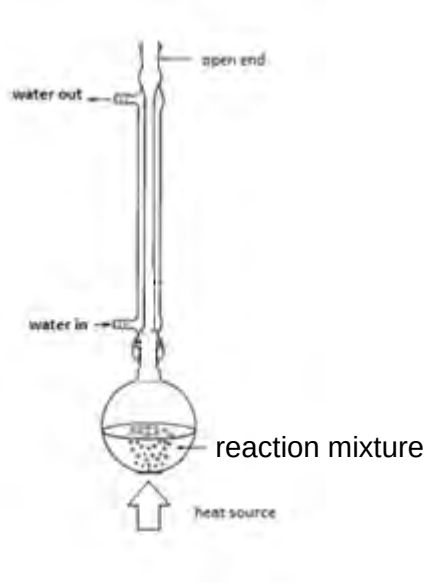
Question number	Answer		Additional Guidance	Mark
2(e)	• potassium manganate(VII) / $KMnO_4$ solution in a burette	**(1)**	Ignore transfer of reaction solution to a conical flask prior to titration Ignore repeating the experiment and averaging results / doing a rough titration then doing an accurate one using the whole reaction mixture Do not award pipette instead of burette	**(5)**
	• add (potassium) manganate(VII) drop by drop (at the end-point)	**(1)**	Ignore transfer slowly	
	• (record the volume when) solution goes (permanent) pink	**(1)**	Ignore initial colour of titration, even if incorrect e.g. from yellow / colourless / pale green / brown to pink all score **(1)** Do not award purple	
	• additional two suggestions that would improve accuracy of endpoint (1 mark for each)	**(2)**	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 If titration is reversed (iron(II) in burette) allow TE max 4	

Question number	Answer		Additional Guidance	Mark
2(f)	• calculation of initial number of moles of Fe^{2+}	**(1)**	Example of calculation: $= \frac{150}{1000} \times 0.0750 = 0.01125 / 1.125 \times 10^{-2}$ (mol) (answer 1)	**(6)**
	• calculation of number of moles of potassium manganate(VII) in titration	**(1)**	$= \frac{9.25}{1000} \times 0.050 = 0.0004625 / 4.625 \times 10^{-4}$ (mol) (answer 2)	
	• calculation of the number of moles of Fe^{2+} remaining after the reactions	**(1)**	(answer 2) $\times 5 = 0.0023125 / 2.3125 \times 10^{-3}$ (mol) (answer 3)	
	• calculation of the number of moles of Fe^{2+} that have reacted	**(1)**	(answer 1) – (answer 3) = 0.01125 – 0.0023125 $= 0.01125 – 0.0023125 = 0.0089375 / 8.9375 \times 10^{-3}$ (mol) (answer 4)	
	• calculation of the number of moles of chlorate ions that have reacted	**(1)**	$\frac{\text{(answer 4)}}{6} = 0.0014895833 / 1.48958 \times 10^{-3}$ (mol) (answer 5)	
	• calculation of the concentration of the solution	**(1)**	= answer 5 ÷ 0.050 = 0.0297917 / 2.97917×10^{-2} (mol dm^{-3}) Allow TE for each stage Ignore SF including 1SF Penalise incorrect units in final mark only Correct answer with no working scores (0)	

Question number	Answer	Additional Guidance	Mark
2(g)	An explanation that makes reference to the following points: • 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)**	M2 dependent on M1 being scored or an incorrect description of chloride ions / chlorine ions reacting with Fe^{2+} Allow just 'chloride ions will react with manganate(VII) ions' Ignore reaction of Fe^{2+} with chloride ions Do not award 'chlorine ions' Allow increase in calculated excess Fe^{2+}, decrease in calculated reacted Fe^{2+} or calculated moles of ClO_3^-. If more than one is given, all must be correct	**(2)**

(Total for Question 2 = 20 marks)

Question number	Answer	Additional Guidance	Mark
3(a)(i)	An answer that makes reference to the following point: • so that the volatile / toxic benzene doesn't escape from the reaction mixture	Must be some mention of benzene Allow the reaction reaches completion / otherwise the reaction would not be complete / to ensure all the benzene reacts Ignore effect on yield	**(1)**

Question Number	Answer	Additional guidance	Mark
3(a)(ii)	• round-bottomed / pear shaped flask containing mixture **and** heat **(1)** • vertical condenser with water jacket **and** water flowing in the correct direction **(1)** • no gaps and open condenser and apparatus would work **(1)**	Example of diagram:  M1 Allow any indication of heat including an arrow or water bath or electrical heater Do not award conical flask/flask with no liquid in Ignore anti bumping granules 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. Ignore stirrer down condenser Do not award if the condenser and flask are one piece of apparatus Allow just M1 for distillation apparatus	**(3)**

Question number	Answer		Additional Guidance	Mark
3(a)(iii)	An answer that makes reference to the following points: • reactants are immiscible / form separate layers / do not mix	(1)	Allow are not completely miscible Allow to make the reactants mix	(2)
	• (the reactants need to be mixed) to ensure enough contact for a reaction to take place	(1)	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'	

Question number	Answer	Additional Guidance	Mark
3(b)	An answer that makes reference to the following points: • (anhydrous) sodium sulfate / Na_2SO_4 / magnesium sulfate / $MgSO_4$ / calcium chloride / $CaCl_2$	Allow silica gel If both the name and formula are given both must be correct Do not award anhydrous copper sulfate / anhydrous cobalt chloride / conc sulfuric acid	(1)

Question number	Answer	Additional Guidance	Mark
3(c)(i)	An answer that makes reference to the following point: • HNO_2 / nitrous acid is unstable / decomposes (so cannot be transported)	Ignore difficult to store Do not award reacts to form nitric acid	(1)

Question number	Answer	Additional Guidance	Mark
3(c)(ii)	An explanation that makes reference to the following points: • below 0^oC the reaction is too slow **(1)** • above 10^oC the diazonium chloride / compound / ion decomposes / hydrolyses / reacts with water / forms phenol (and nitrogen gas) **(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 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	(2)

Question number	Answer	Additional Guidance	Mark
3(d)(i)	An answer that makes reference to the following point: • (so a lot of the azo dye) does not remain in solution (when it cools) **or** gives a saturated solution (when it has cooled)	Ignore 'to obtain a concentrated solution' Do not award just to maximize yield	**(1)**

Question number	Answer	Additional Guidance	Mark
3(d)(ii)	An answer that makes reference to the following point: • (pre-heated) to prevent (premature) crystallisation (of the azo dye in the funnel)	Allow to keep the Organol Brown / product / solid in solution Ignore it remains in the liquid state	**(1)**

Question number	Answer	Additional Guidance	Mark
3(d)(iii)	An answer that makes reference to the following points: • Step **2** is to remove **insoluble** impurities **(1)** • Step **3** is to remove **soluble** impurities **(1)**	If no other mark is scored just 'to remove insoluble and soluble impurities' scores **(1)** Do not award 'to remove soluble and insoluble impurities'	**(2)**

Question number	Answer	Additional Guidance	Mark
3(d)(iv)	An answer that makes reference to the following point: • 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: • sharp melting temperature	 Allow any indication of a small range (±2^{o}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

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