



Mark Scheme (Results)

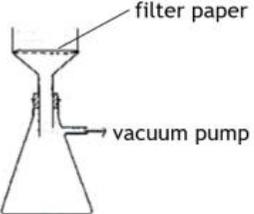
January 2025

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

Question Number	Answer	Additional Guidance	Mark
1(a)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> green / violet 	Allow purple / lilac Ignore shades e.g. 'dark' 'light' etc Do not award yellow Do not award red Do not award precipitate / ppt / solid	(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"> $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ 	Allow absence of the square brackets Allow correct overall charge shown anywhere on complex	(1)

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> $\text{Cr}(\text{OH})_3$ / $[\text{Cr}(\text{H}_2\text{O})_3(\text{OH})_3]$ 	Allow absence of the square brackets Do not award charges on complex	(1)

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	<p>An answer that makes reference to the following points:</p> <p>A diagram showing</p> <ul style="list-style-type: none"> • Buchner funnel and labelled filter paper • Buchner flask with side arm and bung / seal • (side arm connected to) vacuum pump 	<p><u>Example of diagram</u></p>  <p>(1) Funnel must show perforations/holes below the filter paper Allow any properly shaped Buchner / Hirsch funnel Allow sintered glass funnel Do not award porous paper Do not award fluted filter paper</p> <p>(1) Comment Allow conical flask with side arm Do not award side arm through and into flask Allow any 'flask' with a side arm, provided it has a flat bottom in M2</p> <p>(1) Allow vacuum / pump /reduced pressure / aspirator / suction / water pump / air out Ignore direction of any arrows Do not award pressure out/negative pressure Do not award water supply connected directly to flask</p>	(3)

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"> faster produces drier product / removes more of solvent 	<p>Note – must be a comparative statement for M1</p> <p>(1) Allow it takes less time / it's time saving Ignore 'more effective' / 'more efficient'</p> <p>(1) Allow it dries the product / the product is easy to dry Allow description of drying e.g. removes maximum amount of liquid Ignore removes more of the soluble impurities / produces more filtrate</p> <p>Do not award removes more of the insoluble impurities</p>	(2)

Question Number	Answer	Additional Guidance	Mark
1(c)	<p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> solid(s) / MnO₂ / Q dissolve(s) orange (solution) forms 	<p>(1) Allow Q disappears Ignore colour of MnO₂ / Q Ignore fizzing</p> <p>(1) Ignore any initial colours e.g. green Ignore references to pale pink (of Mn²⁺) Do not award yellow as final colour Do not award orange solid / precipitate / ppt</p>	(2)

Question Number	Answer	Additional Guidance	Mark
1(d)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> $[\text{Cr}(\text{OH})_4(\text{H}_2\text{O})_2]^- / [\text{Cr}(\text{OH})_5(\text{H}_2\text{O})]^{2-} / [\text{Cr}(\text{OH})_6]^{3-}$ 	Allow absence of the square brackets Allow correct overall charge shown anywhere on complex	(1)

Question Number	Answer	Additional Guidance	Mark
1(d)(ii)	An answer that makes reference to the following point: <ul style="list-style-type: none"> deprotonation 	Allow acid-base Ignore amphoteric / neutralisation Do not award ligand exchange / oxidation	(1)

(Total for Question 1 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> lone pair on oxygen is delocalised into ring / lone pair on oxygen overlaps with π bond(s) increasing electron density of the ring / making the ring more susceptible to electrophilic attack (so catalyst is not needed) 	<p>(1) Ignore 'lone pair on OH group' Allow lone pair on oxygen goes into the ring</p> <p>(1) Ignore charge density / any reaction conditions Comment ring / π bond(s) must be mentioned at least once to score both marks</p>	(2)

Question Number	Answer	Additional Guidance	Mark
2(b)	<p>An answer that makes reference to two of the following points:</p> <ul style="list-style-type: none"> water direction is the wrong way round so would result in ineffective cooling condenser is sealed/closed (by thermometer adaptor) so pressure would build up (on heating) / risk of explosion (on heating) anti bumping granules omitted so boiling will not be smooth 	<p>(1) Allow water direction is the wrong way round so condenser would not fill with water / (air) bubbles present in condenser Allow reduces efficiency of condensation Ignore effectivity of condenser</p> <p>(1) Ignore references to thermometer placement</p> <p>If neither or M1 and M2 awarded, then allow 1 mark for two correctly identified mistakes</p>	(2)

Question Number	Answer	Additional Guidance	Mark
2(c)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> nitric(III) acid 	Allow nitric acid (III) Accept nitrous acid Allow nitrious acid	(1)

Question Number	Answer	Additional Guidance	Mark
2(c)(ii)	An answer that makes reference to the following point: <ul style="list-style-type: none"> HNO₂ is unstable / decomposes 	allow HNO ₂ disproportionates ignore HNO ₂ evaporates / is expensive / oxidises / toxic / volatile	(1)

Question Number	Answer	Additional Guidance	Mark
2(c)(iii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • to make sure the contents of the test tube(s) are at a temperature between 0 and 10°C • because the diazonium (ion) decomposes / hydrolyses / reacts with water / forms phenol (and nitrogen gas) / is thermally unstable (above 10°C) 	<p>(1) Allow any given temperature within the range Allow to make sure the contents of the test tube(s) are cold enough Ignore references to exothermic reaction</p> <p>(1) Allow diazonium compound / diazonium chloride Ignore any references to reaction rate</p> <p>Do not award for decomposition of other substances e.g. azo dye / phenylamine</p>	(2)

Question Number	Answer	Additional Guidance	Mark
2(c)(iv)	<p>An explanation that makes reference to three of the following points</p> <ul style="list-style-type: none"> • minimum (hot ethanol) is used to reduce amount of azo dye that remains dissolved (after crystallisation / at room temperature / as ethanol cools) • as both compounds / (soluble) impurities and product dissolve in hot ethanol • the (soluble) impurities dissolve (fully) in both hot ethanol and room temperature ethanol • the azo dye is (far more) soluble in hot ethanol (than in room temperature ethanol) • insoluble impurities can be filtered out whilst the solution is hot 	<p>Allow 'cold ethanol' as alternative for 'room temperature ethanol' Allow 'solvent' for ethanol</p> <p>(1) Allow minimum (hot ethanol) is used maximise yield / give a bigger yield / get most of the product Ignore to make a saturated solution</p> <p>(1)</p> <p>(1) Allow to remove soluble impurities</p> <p>(1) Allow at room temperature ethanol the azo dye is (far) less soluble / recrystallizes</p> <p>Allow hot ethanol prevents premature crystallisation (of product) / hot ethanol dissolves the azo dye completely</p> <p>(1)</p>	(3)

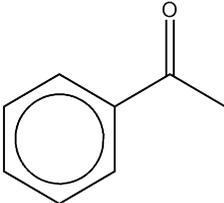
Question Number	Answer	Additional Guidance	Mark
2(c)(v)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none">• in a desiccator / in a (warm) oven	<p>Allow between pieces of filter paper / pat dry with filter paper / leave on filter paper overnight Allow in a low temperature oven Ignore adding a drying agent such as calcium chloride in the context of a desiccator</p>	(1)

Question Number	Answer	Additional Guidance	Mark
2(d)	<p>An answer that makes reference to three of the following points:</p> <ul style="list-style-type: none"> • wear gloves as phenylamine is corrosive / can cause skin burns / is toxic (1) • use in a fume cupboard as phenylamine is toxic / harmful to health / carcinogenic (1) • minimise amounts used as phenylamine is toxic / harmful to health (1) • ensure any waste is place in sealed containers / ensure waste is not release into environment / dispose of (waste) safely as it is hazardous to the environment (1) 	<p>Allow health hazard as alternative to harmful to health</p> <p>Allow avoid ingestion as phenylamine is toxic / harmful to health Ignore face masks / respirators / just ‘cupboard’</p> <p>Allow do not pour waste (solutions) down the sink as phenylamine is hazardous to the environment / harmful to the environment / dangerous to the environment</p> <p>Ignore just ‘causes environmental problem’ for reason point</p> <p>If no other marks scored allow 1 mark for 3 correct precautions with incorrect / insufficient / no reasoning OR Allow 1 mark for 3 correctly identified hazard symbols (corrosive, (acutely) toxic, (serious) health hazard, hazardous to the environment)</p>	(3)

(Total for Question 2 = 15 marks)

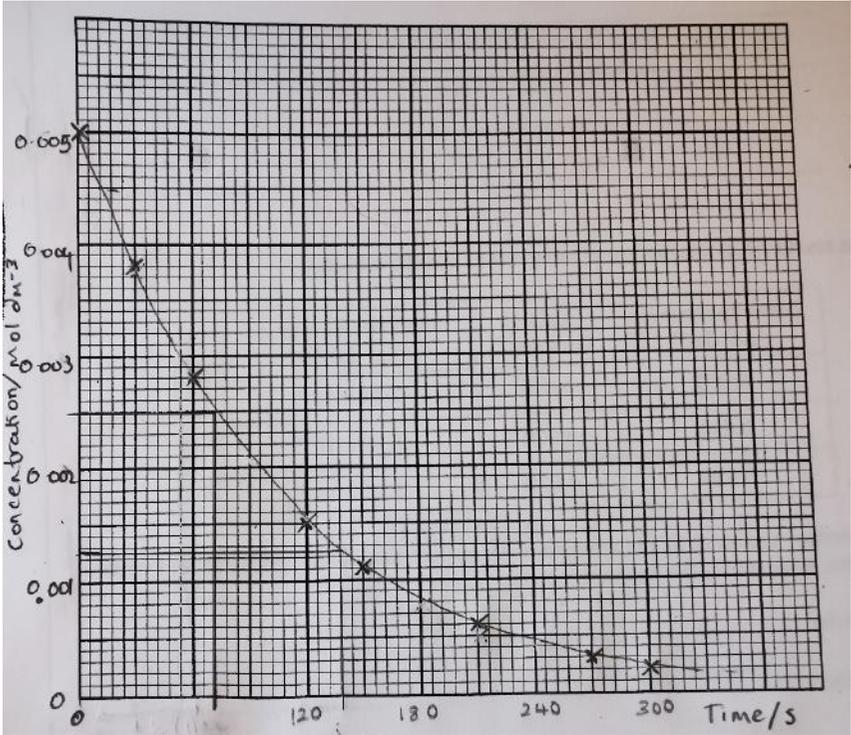
Question Number	Answer	Additional Guidance	Mark
3(a)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • smoky flame indicates X contains a benzene (ring / group)/ phenyl group • orange precipitate (with Brady's reagent) / reaction with Brady's reagent indicates carbonyl (group) / C=O • no red precipitate (with Fehling's reagent) / no reaction with Fehling's reagent indicates it must be a ketone • yellow precipitate (with iodine in NaOH(aq)) / reaction with iodine in NaOH(aq) indicates it must be a methyl ketone / contains CH₃CO group 	<p>(1) Allow smoky flame indicates X is aromatic Allow high C:H ratio / alkene / C=C / unsaturated / high proportion of C Ignore large amount of C</p> <p>(1) Allow contains an aldehyde or ketone (group) Do not award COOH group</p> <p>(1) Allow cannot be an aldehyde</p> <p>(1) Allow acetone</p>	(4)

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"> • calculation of mass of C and H • calculation of mass of oxygen in X • calculation of moles of C, H and O • calculation of ratio and deduction of empirical formula <p>Alternative method</p> <ul style="list-style-type: none"> • calculation of moles of CO₂ and H₂O • calculation of moles of C and H • calculation of moles of O • calculation of ratio and deduction of empirical formula 	<p><u>Example of calculation</u></p> <table border="1" data-bbox="1048 339 1966 624"> <thead> <tr> <th>Element</th> <th>C</th> <th>H</th> <th>O</th> </tr> </thead> <tbody> <tr> <td>mass (g)</td> <td>$13.80 \times (12 \div 44) = 3.764$</td> <td>$2.82 \times (2 \div 18) = 0.313$</td> <td>$4.70 - (3.764 + 0.313) = 0.623$</td> </tr> <tr> <td>moles (mol)</td> <td>$3.764 \div 12 = 0.314$</td> <td>$0.313 \div 1 = 0.313$</td> <td>$0.623 \div 16 = 0.0389$</td> </tr> <tr> <td>ratio</td> <td>$0.314 \div 0.0389 = 8.07$</td> <td>$0.313 \div 0.0389 = 8.05$</td> <td>$0.0389 \div 0.0389 = 1$</td> </tr> </tbody> </table> <p>C₈H₈O</p> <p>Correct empirical formula with some working scores 4 marks Empirical formula alone just scores M4 Allow TE throughout</p> <p>$13.8 \div 44 = 0.31364$ (mol) and $2.82 \div 18 = 0.15667$ (mol)</p> <p>moles of C = 0.31364 (mol) and moles H = $(0.15667 \times 2) = 0.31333$ (mol)</p> <p>$4.70 - [(0.31364 \times 12) + (0.31333 \times 1)] = 0.62299$ (g) $0.62299 \div 16 = 0.03894$ (mol)</p> <p>as for M4 in first method</p> <p>Ignore SF except 1SF in M1 to M3 Ignore minor rounding errors</p>	Element	C	H	O	mass (g)	$13.80 \times (12 \div 44) = 3.764$	$2.82 \times (2 \div 18) = 0.313$	$4.70 - (3.764 + 0.313) = 0.623$	moles (mol)	$3.764 \div 12 = 0.314$	$0.313 \div 1 = 0.313$	$0.623 \div 16 = 0.0389$	ratio	$0.314 \div 0.0389 = 8.07$	$0.313 \div 0.0389 = 8.05$	$0.0389 \div 0.0389 = 1$	(4)
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Question Number	Answer	Additional Guidance	Mark
3(c)	An answer that makes reference to the following point: <ul style="list-style-type: none"> •  	Allow skeletal, structural, displayed or hybrid formulae Allow TE from formula in (b) but must have benzene ring and carbonyl group Ignore names	(1)

(Total for Question 3 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	<ul style="list-style-type: none">• colorimetry	Allow colorimeter Ignore light detector Comment If second incorrect technique shown and not crossed out then DNA	(1)

Question Number	Answer	Additional Guidance	Mark
4(a)(ii)	<ul style="list-style-type: none"> • axes labelled with units, with time on x axis, concentration (of In^{2+}) on y axis (1) • suitable scale where points plotted cover at least half the available space (1) • all points plotted within $\pm\frac{1}{2}$ a small square and smooth curve drawn (1) 	<p><u>Example of graph</u></p>  <p>Allow t/s Do not award T/s</p>	(3)

Question Number	Answer	Additional Guidance	Mark
4(a)(iii)	<ul style="list-style-type: none"> • first half-life determined • second half-life determined, consecutive with first <p>Comment if 2 half-lives given are within range but there is no evidence of working on the graph allow 1 mark max</p>	<p><u>Example of calculation</u></p> <p>(1) 72 (s)</p> <p>(1) $138 - 72 = 66$ (s)</p> <p>Accept two values between 60 and 75</p> <p>Allow two half-lives that are not successive</p> <p>Allow half-lives shown in (iv)</p>	(2)

Question Number	Answer	Additional Guidance	Mark
4(a)(iv)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • first order (with respect to \ln^{2-}) • as (successive) half-lives are (approximately) constant 	<p>(1) M1 is standalone regardless of half-lives in (iii)</p> <p>(1) M2 is dependent on similar /constant half lives in (iii)</p> <p>Comment If 2nd half life is incorrectly calculated to be approximately double that of the first half life, allow 1 mark for 2nd order, as half-lives double / are not constant</p>	(2)

Question Number	Answer	Additional Guidance	Mark
4(a)(v)	<p>An explanation that makes reference to the following points:</p> <p>EITHER</p> <ul style="list-style-type: none"> • as hydroxide (ions) are in (large) excess (1) • so as hydroxide ions react the change in their concentration is negligible / their concentration remains constant (so does not affect the rate) (1) <p>OR (to find the overall order)</p> <ul style="list-style-type: none"> • carry out another experiment where $[\text{OH}^-]$ changes (1) • and $[\text{In}^{2-}]$ is kept constant (1) 	<p>Allow KOH / NaOH is in (large) excess Ignore references to limiting factor</p>	(2)

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	<ul style="list-style-type: none"> <li data-bbox="353 309 1025 341">• calculation of difference in x and difference in y <li data-bbox="353 459 696 491">• calculation of gradient <li data-bbox="353 609 1106 673">• calculation of activation energy to 2 or 3 SF, including units 	<p data-bbox="1245 233 1547 264"><u>Example of calculation</u></p> <p data-bbox="1178 309 1630 411">(1) $0.00337 - 0.00317 = 0.00020$ $-5.75 + 4.39 = (-) 1.36$ M1 could be subsumed in M2</p> <p data-bbox="1178 459 1800 561">(1) $-1.36 \div 0.00020 = - 6800$ (K) M2 could be subsumed in M3 Allow gradient in range of -6200 to -7000</p> <p data-bbox="1178 609 1608 673">(1) $6800 \times 8.31 = 56508$ $= (+) 56500 / 57000 \text{ J mol}^{-1}$</p> <p data-bbox="1245 721 1626 753">Accept (+) $56.5 / 57 \text{ kJ mol}^{-1}$</p> <p data-bbox="1245 801 1877 865">Final correct answer with some working scores 3 marks</p> <p data-bbox="1245 912 1805 1008">Allow TE from M1 to M2 Allow TE from M2 to M3 if final answer is positive</p>	(3)

Question Number	Answer	Additional Guidance	Mark
4(b)(ii)	<ul style="list-style-type: none"> no, as value for \ln (collision factor) is the y intercept when $x = 0$ 	<p>Allow graph shows $\ln(\text{rate})$ which may / will not give the same y intercept as $\ln k$</p> <p>Allow possible proof based on calculation of $\ln(\text{collision factor})$ using Arrhenius equation (e.g. value of 17, based on a gradient of -6800)</p>	(1)

(Total Marks for Question 4 = 14 marks)