Mark Scheme (Results)

January 2025

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

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January 2025
Question Paper Log Number P78460A
Publications Code WCH16_01_2501_MS

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.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

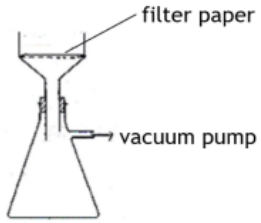
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Answer	Additional Guidance	Mark
1(a)(i)	An answer that makes reference to the following point: • 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: • $[Cr(H_2O)_6]^{3+}$	 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: • $Cr(OH)_3$ / $[Cr(H_2O)_3(OH)_3]$	 Allow absence of the square brackets Do not award charges on complex	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	An answer that makes reference to the following points: A diagram showing • Buchner funnel and labelled filter paper **(1)** • Buchner flask with side arm and bung / seal **(1)** • (side arm connected to) vacuum pump **(1)**	<u>Example of diagram</u>  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 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 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	**(3)**

Question Number	Answer	Additional Guidance	Mark
1(b)(iii)	An answer that makes reference to the following points: • faster **(1)** • produces drier product / removes more of solvent **(1)**	Note – must be a comparative statement for M1 Allow it takes less time / it's time saving Ignore 'more effective'/ 'more efficient' 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 Do not award removes more of the **insoluble** impurities	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(c)	A description that makes reference to the following points: • solid(s) / MnO_2 / Q dissolve(s) **(1)** • orange (solution) forms **(1)**	 Allow Q disappears Ignore colour of MnO_2 / Q Ignore fizzing Ignore any initial colours e.g. green Ignore references to pale pink (of Mn^{2+}) Do not award yellow as final colour Do not award orange solid / precipitate / ppt	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(d)(i)	An answer that makes reference to the following point: • $[Cr(OH)_4(H_2O)_2]^-$ / $[Cr(OH)_5(H_2O)]^{2-}$ / $[Cr(OH)_6]^{3-}$	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: • 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)	An explanation that makes reference to the following points: • lone pair on oxygen is delocalised into ring / lone pair on oxygen overlaps with π bond(s) **(1)** • increasing electron density of the ring / making the ring more susceptible to electrophilic attack (so catalyst is not needed) **(1)**	Ignore 'lone pair on OH group' Allow lone pair on oxygen goes into the ring Ignore charge density / any reaction conditions Comment ring / π bond(s) must be mentioned at least once to score both marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)	An answer that makes reference to two of the following points: • water direction is the wrong way round so would result in ineffective cooling **(1)** • condenser is sealed/closed (by thermometer adaptor) so pressure would build up (on heating) / risk of explosion (on heating) **(1)** • anti bumping granules omitted so boiling will not be smooth	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 Ignore references to thermometer placement If neither or M1 and M2 awarded, then allow 1 mark for two correctly identified mistakes	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(c)(i)	An answer that makes reference to the following point: • 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: • HNO_2 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)	An explanation that makes reference to the following points: • to make sure the contents of the test tube(s) are at a temperature between 0 and 10°C **(1)** • because the diazonium (ion) decomposes / hydrolyses / reacts with water / forms phenol (and nitrogen gas) / is thermally unstable (above 10°C) **(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 Allow diazonium compound / diazonium chloride Ignore any references to reaction rate Do not award for decomposition of other substances e.g. azo dye / phenylamine	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(c)(iv)	An explanation that makes reference to three of the following points • minimum (hot ethanol) is used to reduce amount of azo dye that remains dissolved (after crystallisation / at room temperature / as ethanol cools) **(1)** • as both compounds / (soluble) impurities and product dissolve in **hot** ethanol **(1)** • the (soluble) impurities dissolve (fully) in both hot ethanol and room temperature ethanol **(1)** • the azo dye is (far more) soluble in **hot** ethanol (than in room temperature ethanol) **(1)** • insoluble impurities can be filtered out whilst the solution is hot **(1)**	Allow 'cold ethanol' as alternative for 'room temperature ethanol' Allow 'solvent' for ethanol Allow minimum (hot ethanol) is used maximise yield / give a bigger yield / get most of the product Ignore to make a saturated solution Allow to remove soluble impurities Allow at room temperature ethanol the azo dye is (far) less soluble / recrystallizes Allow hot ethanol prevents premature crystallisation (of product) / hot ethanol dissolves the azo dye completely	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(c)(v)	An answer that makes reference to the following point: • in a desiccator / in a (warm) oven	 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	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(d)	An answer that makes reference to three of the following points: • wear gloves **(1)** as phenylamine is corrosive / can cause skin burns / is toxic • 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 **(1)** as it is hazardous to the environment	Allow health hazard as alternative to harmful to health Allow avoid ingestion as phenylamine is toxic / harmful to health Ignore face masks / respirators / just 'cupboard' Allow do not pour waste (solutions) down the sink as phenylamine is hazardous to the environment / harmful to the environment / dangerous to the environment Ignore just 'causes environmental problem' for reason point 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)	**(3)**

(Total for Question 2 = 15 marks)

Question Number	Answer		Additional Guidance	Mark
3(a)	An answer that makes reference to the following points:			**(4)**
	• smoky flame indicates X contains a benzene (ring / group)/ phenyl group	**(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	
	• orange precipitate (with Brady's reagent) / reaction with Brady's reagent indicates carbonyl (group) / C=O	**(1)**	Allow contains an aldehyde **or** ketone (group) Do not award COOH group	
	• no red precipitate (with Fehling's reagent) / no reaction with Fehling's reagent indicates it must be a ketone	**(1)**	Allow cannot be an aldehyde	
	• yellow precipitate (with iodine in NaOH(aq) / reaction with iodine in NaOH(aq) indicates it must be a methyl ketone / contains CH_3CO group	**(1)**	Allow acetoketone	

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>3(b)</td><td>An answer that makes reference to the following points:

• calculation of mass of C and H (1)

• calculation of mass of oxygen in X (1)

• calculation of moles of C, H and O (1)

• calculation of ratio and deduction of empirical formula (1)

Alternative method

• calculation of moles of CO_2 and H_2O

• calculation of moles of C and H

• calculation of moles of O

• calculation of ratio and deduction of empirical formula</td><td><u>Example of calculation</u>

<table><tr><td>Element</td><td>C</td><td>H</td><td>O</td></tr><tr><td>mass (g)</td><td>13.80 × (12÷44) = 3.764</td><td>2.82 × (2÷18) = 0.313</td><td>4.70 – (3.764 + 0.313) = 0.623</td></tr><tr><td>moles (mol)</td><td>3.764 ÷12 = 0.314</td><td>0.313 ÷ 1 = 0.313</td><td>0.623 ÷ 16 = 0.0389</td></tr><tr><td>ratio</td><td>0.314÷0.0389= 8.07</td><td>0.313÷0.0389 = 8.05</td><td>0.0389 ÷0.0389 = 1</td></tr></table>
C_8H_8O

Correct empirical formula with some working scores 4 marks
Empirical formula alone just scores M4
Allow TE throughout

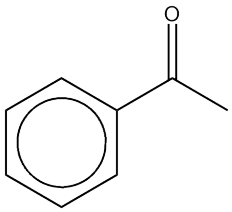
13.8 ÷ 44 = 0.31364 (mol) and 2.82 ÷ 18 = 0.15667 (mol)

moles of C = 0.31364 (mol) and moles H = (0.15667 × 2) = 0.31333 (mol)

4.70 – [(0.31364 × 12) + (0.31333 × 1)] = 0.62299 (g)
0.62999 ÷ 16 = 0.03894 (mol)

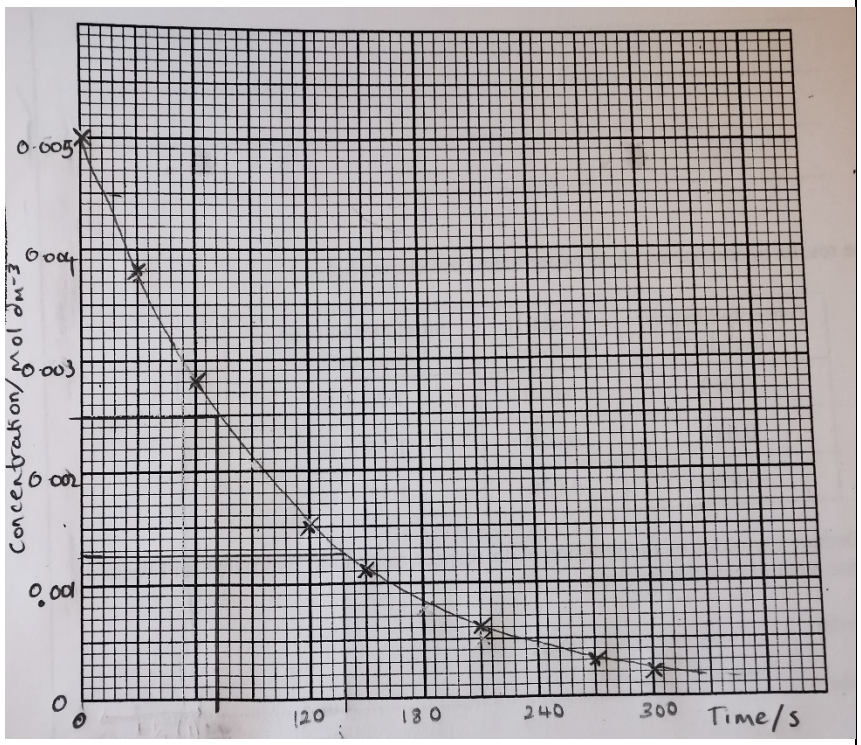
as for M4 in first method

Ignore SF except 1SF in M1 to M3
Ignore minor rounding errors</td><td>(4)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
3(c)	An answer that makes reference to the following point: • 	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)	• 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)	• 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 ±½ a small square **and** smooth curve drawn **(1)**	Example of graph  Allow t/s Do not award T/s	**(3)**

Question Number	Answer	Additional Guidance	Mark
4(a)(iii)	• first half-life determined **(1)** • second half-life determined, consecutive with first **(1)** Comment if 2 half-lives given are within range but there is no evidence of working on the graph allow 1 mark max	<u>Example of calculation</u> 72 (s) 138 − 72 = 66 (s) Accept two values between 60 and 75 Allow two half-lives that are not successive Allow half-lives shown in (iv)	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(a)(iv)	An answer that makes reference to the following points: • first order (with respect to In^{2-}) **(1)** • as (successive) half-lives are (approximately) constant **(1)**	M1 is standalone regardless of half-lives in (iii) M2 is dependent on similar /constant half lives in (iii) 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	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(a)(v)	An explanation that makes reference to the following points: EITHER • 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)** OR (to find the overall order) • carry out another experiment where $[OH^-]$ changes **(1)** • and $[In^{2-}]$ is kept constant **(1)**	Allow KOH / NaOH is in (large) excess Ignore references to limiting factor	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	• calculation of difference in x and difference in y **(1)** • calculation of gradient **(1)** • calculation of activation energy to 2 or 3 SF, including units **(1)**	<u>Example of calculation</u> 0.00337 – 0.00317 = 0.00020 −5.75 + 4.39 = (−) 1.36 M1 could be subsumed in M2 −1.36 ÷ 0.00020 = − 6800 (K) M2 could be subsumed in M3 Allow gradient in range of −6200 to −7000 6800 × 8.31 = 56508 = (+) 56500 / 57000 J mol^{-1} Accept (+) 56.5 / 57 kJ mol^{-1} Final correct answer with some working scores 3 marks Allow TE from M1 to M2 Allow TE from M2 to M3 if final answer is positive	**(3)**

Question Number	Answer	Additional Guidance	Mark
4(b)(ii)	• no, as value for ln (collision factor) is the y intercept when x = 0	Allow graph shows ln(rate) which may / will not give the same y intercept as ln*k* Allow possible proof based on calculation of ln(collision factor) using Arrhenius equation (e.g. value of 17, based on a gradient of −6800)	**(1)**

(Total Marks for Question 4 = 14 marks)

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