Mark Scheme (Results)

January 2015

Pearson Edexcel International Advanced level in Chemistry (WCH05) Paper 01

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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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

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.

Section A (multiple choice)

Question Number	Correct Answer	Reject	Mark
1	A		1

Question Number	Correct Answer	Reject	Mark
2	D		1

Question Number	Correct Answer	Reject	Mark
3	D		1

Question Number	Correct Answer	Reject	Mark
4	B		1

Question Number	Correct Answer	Reject	Mark
5	A		1

Question Number	Correct Answer	Reject	Mark
6	D		1

Question Number	Correct Answer	Reject	Mark
7	C		1

Question Number	Correct Answer	Reject	Mark
8	B		1

Question Number	Correct Answer	Reject	Mark
9	D		1

Question Number	Correct Answer	Reject	Mark
10	C		1

Question Number	Correct Answer	Reject	Mark
11	B		1

Question Number	Correct Answer	Reject	Mark
12	B		1

Question Number	Correct Answer	Reject	Mark
13	C		1

Question Number	Correct Answer	Reject	Mark
14	B		1

Question Number	Correct Answer	Reject	Mark
15	A		1

Question Number	Correct Answer	Reject	Mark
16	A		1

Question Number	Correct Answer	Reject	Mark
17	B		1

Question Number	Correct Answer	Reject	Mark
18	D		1

Question Number	Correct Answer	Reject	Mark
19	C		1

Question Number	Correct Answer	Reject	Mark
20	B		1

Total for Section A = 20 marks

Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	Penalise omission of charge on NO_3^- only once in (a)(i) and (a)(ii) Penalise an incorrect coefficient in (a)(i) and (a)(ii) once only $Cu^{2+} + 2e^{(-)} \rightarrow Cu$ ($E^\ominus$ = +0.34 V) **(1)** $2NO_3^- + 4H^+ + 2e^{(-)} \rightarrow N_2O_4 + 2H_2O$ ($E^\ominus$ = +0.80 V) ALLOW multiples equations reversed reversible / double-headed arrows 2 NO_2 for N_2O_4 **(1)** IGNORE $E^\ominus$ at this point State symbols even if incorrect	Alternative nitrate(V) reductions	2

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	$Cu + 2NO_3^- + 4H^+ \rightarrow Cu^{2+} + N_2O_4 + 2H_2O$ ALLOW multiples reversible / double-headed arrows 2 NO_2 for N_2O_4 **(1)** No TE for equation from incorrect half-equations $E^\ominus_{cell}$ (= +0.80 − 0.34) = (+)0.46 (V) **(1)** TE for $E^\ominus_{cell}$ value on incorrect selection of half-equations IGNORE State symbols even if incorrect	uncancelled electrons	2

Question Number	Acceptable Answer	Reject	Mark
21(a)(iii)	Brown fumes / gas OR Green solution ALLOW (pale) yellow fumes / gas OR effervescence / bubbling / fizzing OR blue solution IGNORE modifiers of blue IGNORE References to copper dissolving	Colourless gas bubbles	1

Question Number	Acceptable Answer	Reject	Mark
21(b)(i)	In (b)(i) and (b)(ii) penalise (correct) non-ionic equations once. $Cu^{2+} + 2I^- \rightarrow CuI + ½I_2$ OR $2Cu^{2+} + 4I^- \rightarrow Cu_2I_2 + I_2$ ALLOW $Cu^{2+} + I^- \rightarrow Cu^+ + ½I_2$ OR $2Cu^{2+} + 2I^- \rightarrow 2Cu^+ + I_2$ OR Multiples IGNORE State symbols even if incorrect	$Cu(NO_3)_2 + 2KI \rightarrow CuI + ½I_2 + 2KNO_3$	1

Question Number	Acceptable Answer	Reject	Mark
21(b)(ii)	$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$ OR Multiples	$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2KI$	1

Question Number	Acceptable Answer	Reject	Mark
21(b)(iii)	2 mol Cu^{2+} forms 1 mol I_2 which reacts with 2 mol $S_2O_3^{2-}$ OR Multiples in this explanation OR Any clear explanation in words No TE on incorrect equations in (b)(i) and (b)ii)	**Just** re-writing the equations.	1

Question Number	Acceptable Answer	Reject	Mark
21(b)(iv)	mol $S_2O_3^{2-}$ in 25 cm^3 = 0.0505 x 26.35 /1000 = 1.330675 x 10^{-3} ans* **(1)** mol Cu^{2+} in 250 cm^3 = mol Cu in sample = 10 x ans* **(1)** = 1.330675 x 10^{-2} ans** mass Cu = ans** x 63.5 = 1.330675 x 10^{-2} x 63.5 **(1)** = 0.84498 (g) ans*** % copper in rivet brass = 100 x ans***/ 1.35 = 62.591/ 62.6 % **(1)** Correct answer with no working scores 4 If incorrect ratio used then max 3 Answers >100% max 3 IGNORE SF except one Do not penalise correct intermediate rounding		4

Question Number	Acceptable Answer	Reject	Mark
21(c)(i)	More iodine would be formed **(1)** (Titre / volume of thiosulfate would be larger) so (calculated) % copper would be higher **(1)** Second mark dependent on first		2

Question Number	Acceptable Answer	Reject	Mark
21(c)(ii)	**MP1 and MP2 are stand alone** **Marking Point 1** Percentage difference in the titres is (approximately) 100 x 0.25/26.35 = 0.94877 / 0.95% **(1)** **Marking Point 2** This MP should only be awarded if the candidate appreciates that the addition of urea **improves** experimental accuracy. The percentage error in the burette reading is (±)100 x 0.1/26.35 = (±)0.3795% **and** so change is a significant improvement OR Difference in titres is greater than uncertainty / error in burette reading OR Calculation any other **specific** apparatus uncertainty **and** use of urea has a significant effect OR Error without urea is significant when compared with the typical apparatus uncertainty (so the addition of urea improves accuracy) **(1)**	1.9% Total apparatus error greater than effect of urea	2

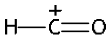
Question Number	Acceptable Answer	Reject	Mark
21(d)(i)	(When the electronic structure is built up according to the *aufbau* rules) the last electron goes into the (3)d-subshell / one of the d-orbitals / the d-orbitals	Just 'electrons present in (3)d-subshell outer / valence electrons are in d-subshell shell for subshell	1

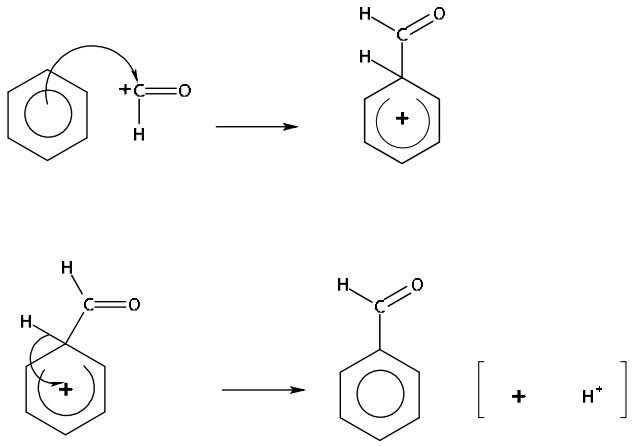
Question Number	Acceptable Answer	Reject	Mark
21(d)(ii)	copper forms (one or more stable) ions having partially filled (3)d orbitals / subshell (but zinc does not) OR Zinc does not form an ion with a partially filled 3(d) orbital/subshell (but copper does)	3d shell Just 'zinc only forms an ion with a full 3d subshell'	1

Question Number	Acceptable Answer	Reject	Mark
21(d)*(iii)	Penalise use of orbital (singular) once only in (d)(iii) and (d)(iv) (3)d orbitals / (3)d subshell split (by the attached ligands) **(1)** Electrons are promoted (from lower to higher energy d orbital(s) / levels) OR Electrons move from lower to higher energy d orbital(s) / levels ALLOW d—d transitions occur **(1)** Absorbing energy /photons of a certain frequency (in the visible region) ALLOW Absorbing light **(1)** Reflected / transmitted / remaining light is coloured / yellow / in the visible region ALLOW Complementary colour seen Reflected / transmitted / remaining light / frequency is seen **(1)** No mention of (3)d then max 3 IGNORE reference to electrons relaxing / dropping to the ground state	Orbital / shell is split d-d splitting emitted	4

Question Number	Acceptable Answer	Reject	Mark
21(d)(iv)	(3)d subshell / (all) (3)d orbitals of zinc(II) are full (so electron transitions are not possible) Ignore No unpaired electrons	(3)d orbital full Full 3d subshell is not split	1

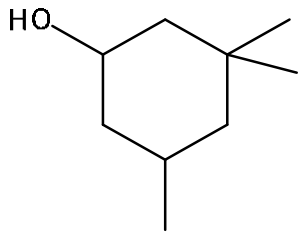
Total for Question 21 = 23 marks

Question Number	Acceptable Answer	Reject	Mark
22(a)(i)	 OR non-displayed structure (with atoms in any order) ALLOW Positive charge on any part of the structure OR Outside bracketed structure / formula	HCOCl / methanoyl chloride	1

Question Number	Acceptable Answer	Reject	Mark
22 (a)(ii)	 TE on incorrect electrophile in (a)(i) Positive charge on any part of the electrophile Curly arrow from on or within the circle to positively charged carbon ALLOW Curly arrow from anywhere within the hexagon Arrow to any part of the CHO^+ including to the + charge Non-displayed electrophile **(1)** Intermediate structure including charge with horseshoe covering at least 3 carbon atoms, **and** facing the tetrahedral carbon **and** some part of the positive charge must be within the horseshoe Ignore structure of side chain for this mark **(1)** Curly arrow from C—H bond to anywhere in the benzene ring reforming delocalized fully correct structure including correctly bonded substituent Substituent may be non-displayed **(1)** Correct Kekulé structures score full marks Ignore any involvement of AlX_4^- (or similar) in the formation of the final structure	Curly arrow on or outside the hexagon Dotted bonds to H and CHO **unless** clearly a dots & wedge 3-D structure COH for CHO	3

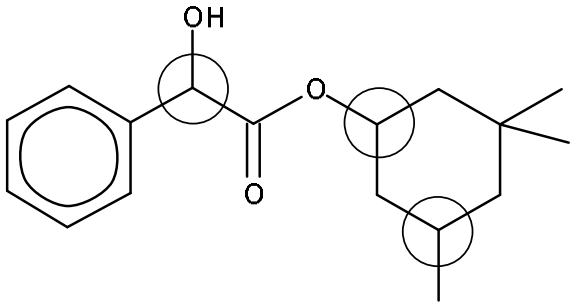
Question Number	Acceptable Answer	Reject	Mark
22(a)(iii)	hydrogen cyanide / HCN **(1)** potassium (or sodium) cyanide / KCN / NaCN ignore pH = 8 **(1)** OR KCN / NaCN **(1)** H_2SO_4 / HCl ignore concentrations and pH = 8 **(1)** OR HCN **(1)** NaOH / pH = 8 **(1)** ALLOW names or formula throughout	 NaOH NaOH	2

Question Number	Acceptable Answer	Reject	Mark
22(a)(iv)	Hydrochloric acid / HCl(aq) OR Sulfuric acid / H_2SO_4(aq) OR sodium hydroxide / NaOH / potassium hydroxide / KOH **and** followed by any **strong** acid / H^+ ALLOW HCl / H_2SO_4 / name or formula of any **strong** acid IGNORE Water / H_2O Concentrated Dilute		1

Question Number	Acceptable Answer	Reject	Mark
22(b)(i)	The first two marks are stand alone  **(1)** (Concentrated) sulfuric acid ALLOW Any named strong acid / correct formula with or without state symbol IGNORE Dilute / water **(1)** (Heat under) reflux **(1)** Condition mark dependent on the reagent mark being awarded or near miss.	OH bonded to ring the wrong way around Benzene ring H^+ / H_3O^+ Just 'heat'	3

Question Number	Acceptable Answer	Reject	Mark
22(b)(ii)	The esterification / reaction is reversible / an equilibrium (So yield is low) ALLOW Does not go to completion IGNORE References to cost/rate No TE on an incorrect reaction in (b)(i)		1

Question Number	Acceptable Answer	Reject	Mark
22(b)(iii)	PCl_5 reacts with both OH groups		1

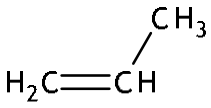
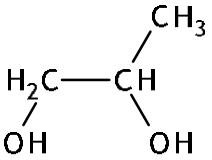
Question Number	Acceptable Answer	Reject	Mark
22(c)(i)	 All three correct scores 2 marks Two correct from three scores 1 mark More than three circled scores max 1 mark ALLOW Any clear labelling Any ring containing only one correct carbon		2

Question Number	Acceptable Answer	Reject	Mark
22(c)(ii)	**Any two from** Only one isomer may be (more) active One isomer (or more) may have a negative effect ALLOW Side effects Different isomers have different (biochemical) properties ALLOW higher dosage required to obtain sufficient amount of active isomer (so expensive) If no other mark is scored Separation of isomers needed OR Low yield can score 1 IGNORE References to **just** 'cost'	Geometric / structural isomers	2

Total for Question 22 = 16 marks

Question Number	Acceptable Answer	Reject	Mark
23(a)	Molar mass of TO_2 = 100 x 32 / 36.82 **(1)** = 86.9093 **(1)** Molar mass of T = 86.9093 – 32 = 54.9 (g mol^{-1}) (hence T is manganese / Mn) **(1)** **OR** Amount of O (in 100g) = 36.82 /16 = 2.3013 mol **(1)** ∴ mol T = 1.1506 weighs 100 – 36.82 = 63.18 g **(1)** 1 mol T weighs 63.18 / 1.1506 = 54.909 g (hence T is manganese / Mn) **(1)** **OR** Percentage of Mn 100 – 36.82 = 63.18 **(1)** Number of moles of Mn = 63.18/54.9 = 1.15 **(1)** Number of moles of oxygen = 36.82/16 = 2.3 (hence TO_2 is MnO_2) **(1)** ALLOW Calculations based on moles of O_2 Correct answer with no working scores **zero**		3

Question Number	Acceptable Answer	Reject	Mark
23(b)(i)	Molecular ion labelled in any way on the mass spectrum **and** Molar mass = 76 (g mol^{-1})		1

Question Number	Acceptable Answer	Reject	Mark
23(b)(ii)	**M**  / CH_2CHCH_3 / propene ALLOW prop-1-ene **(1)** **N**  / $CH_2OHCHOHCH_3$ / propane-1,2-diol ALLOW propan-1,2-diol / 1,2-propan(e)-diol **(1)** IGNORE C_3H_6 and $C_3H_8O_2$		2

Question Number	Acceptable Answer	Reject	Mark
23(c)(i)	IGNORE H_2O ligands in c)i) & c)ii) $Mn^{2+}(aq) + 2OH^-(aq) \rightarrow Mn(OH)_2(s)$ Equation **(1)** States **(1)** ALLOW use of T for Mn states mark for non-ionic equation OR for unbalanced equation with correct species		2

Question Number	Acceptable Answer	Reject	Mark
23(c)(ii)	$MnO_2.nH_2O \rightarrow MnO_2 + nH_2O$ OR $Mn(OH)_4 \rightarrow MnO_2 + 2H_2O$ LHS (1) RHS (1) ALLOW use of T for Mn ALLOW for 1 mark $Mn(OH)_2 + ½O_2 \rightarrow MnO_2 + H_2O$		2

Question Number	Acceptable Answer	Reject	Mark
23(d)	K^+ IGNORE 'potassium ion' **(1)** $KMnO_4$ **(1)** TE on cation given for MP1	Just 'K'	2

Total for Question 23 = 12 marks
Total for Section B = 51 marks

Section C

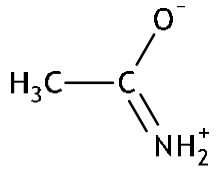
Question Number	Acceptable Answer	Reject	Mark
24(a)(i)	(Both have hydrogen bonds) methylamine has stronger London / dispersion / induced dipole(-induced dipole) / van der Waals forces **(1)** As it has more electrons ALLOW greater surface area **(1)** ALLOW (Both have hydrogen bonds) stronger hydrogen bonds in methylamine because of electron donating effect of the methyl group ..... **(1)** ... makes the nitrogen lone pair more available **(1)** IGNORE just 'hydrogen bonds stronger' If no other marks are scored then 'both molecules have hydrogen bonds **and** London forces' scores 1 mark		2

Question Number	Acceptable Answer	Reject	Mark
24(a)*(ii)	Amines form hydrogen bonds with water (molecules) **(1)** As molar mass (of the amine) increases, the size / strength of the London forces/ dispersion / induced dipole(-induced dipole) / van der Waals forces (between amine molecules) increase ALLOW The size of the hydrophobic group increases **(1)** So the energy needed to break the London forces (of the amines) increases (becomes more and more similar to the energy released in forming hydrogen bonds) OR the nett gain in / release of energy becomes (progressively) smaller **(1)** IGNORE References to hydrophilic groups		3

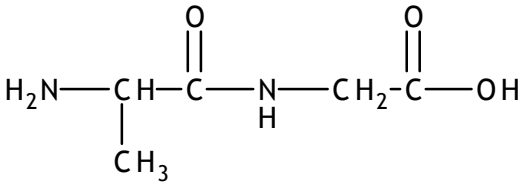
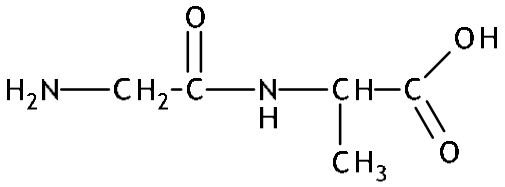
Question Number	Acceptable Answer	Reject	Mark
24(a)(iii)	$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$ ALLOW → for ⇌ & $CH_3NH_3^+$ OH^- IGNORE Position of charges		1

Question Number	Acceptable Answer	Reject	Mark
24(a)(iv)	Basic strength depends on the (donation / availability of) the lone pair (of electrons on the nitrogen atom) ALLOW Basic strength depends on the ability of a nitrogen atom to accept a proton **(1)** Methyl groups are electron donating (so lone pair donation increases / lone pair more available) **(1)** **Lone pair** of (nitrogen on) phenylamine interacts with π / delocalised electrons of the benzene ring (so lone pair donation decreases / lone pair less available) ALLOW **Lone pair** delocalised into the (benzene) ring 'Non-bonding electron pair' for lone pair **(1)**	N becomes more electronegative Just 'electron pair'	3

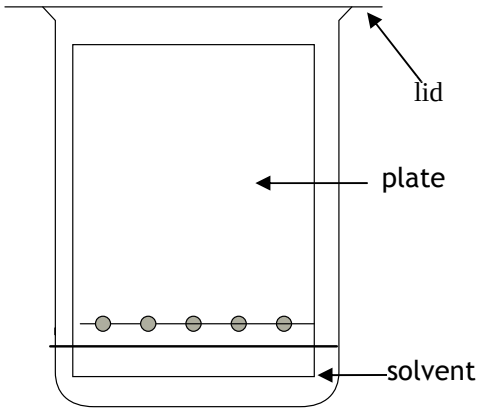
Question Number	Acceptable Answer	Reject	Mark
24(b)(i)	If neither answer refers to an electron **pair** then max 1 for this item **Arrow 1** Movement of **π electron pair** / **π electrons** (to oxygen atom) OR Movement of a pair of electrons from the double bond **(1)** **Arrow 2** Movement of **lone pair** / **non-bonded pair** of electrons (from the nitrogen) (to C—N bond) **(1)** If **neither** of these marks is scored then 'each arrow shows the movement of an electron **pair**' scores 1 mark	Just "breaking of the π bond"	2

Question Number	Acceptable Answer	Reject	Mark
24(b)(ii)			1

Question Number	Acceptable Answer	Reject	Mark
24(b)(iii)	(The electron movement shown above means that) the carbonyl carbon has a smaller (partial) positive charge than an aldehyde or ketone ALLOW no positive charge OR carbonyl carbon is resistant to **nucleophilic** attack		1

Question Number	Acceptable Answer	Reject	Mark
24(c)(i)	One mark for each structure with fully displayed, structural or skeletal formulae and in any orientation   Penalise lack of displayed double bonds once only ALLOW If continuation bonds added to the dimers max 1. Two fully correct polymer structures **(1)**		2

Question Number	Acceptable Answer	Reject	Mark
24(c)(ii)	The amine group (of glycine & alanine) is protonated & cannot act as a nucleophile ALLOW (Glycine & alanine) form zwitterions IGNORE References to activation energy		1

Question Number	Acceptable Answer	Reject	Mark
24(c)*(iii)	Dot samples of the amino acid mixture (and known amino acids) on the plate and dip the plate in the solvent (1) Use of ninhydrin to make amino acids visible / as a developer (1) Compare distance travelled of mixture components and known amino acids OR Compare R_f with data book values (1) The first mark may be awarded for a suitable diagram e.g.  ALLOW 'Paper' or 'glass slide' for 'plate' IGNORE Omission of lid in diagram.	Amino acids dissolved in mobile phase solvent	3

Total for Section C = 19 marks
Total for paper = 90 marks