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Mark Scheme (Results)

June 2014

International GCE Chemistry (6CH05/01R)

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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

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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.

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Section A (multiple choice)

Question Number	Correct Answer	Reject	Mark
1	C		1

Question Number	Correct Answer	Reject	Mark
2	A		1

Question Number	Correct Answer	Reject	Mark
3	D		1

Question Number	Correct Answer	Reject	Mark
4	A		1

Question Number	Correct Answer	Reject	Mark
5 (a)	C		1
5 (b)	B		1

Question Number	Correct Answer	Reject	Mark
6	A		1

Question Number	Correct Answer	Reject	Mark
7	B		1

Question Number	Correct Answer	Reject	Mark
8	D		1

Question Number	Correct Answer	Reject	Mark
9	A		1

Question Number	Correct Answer	Reject	Mark
10	D		1

Question Number	Correct Answer	Reject	Mark
11	B		1

Question Number	Correct Answer	Reject	Mark
12	B		1

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Question Number	Correct Answer	Reject	Mark
13	B		1

Question Number	Correct Answer	Reject	Mark
14	D		1

Question Number	Correct Answer	Reject	Mark
15	C		1

Question Number	Correct Answer	Reject	Mark
16	A		1

Question Number	Correct Answer	Reject	Mark
17	C		1

Question Number	Correct Answer	Reject	Mark
18	B		1

Question Number	Correct Answer	Reject	Mark
19	B		1

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Section B

Question Number	Acceptable Answers	Reject	Mark
20 (a)(i)	$Fe^{2+} \rightarrow Fe^{3+} + e^{(-)}$ $½O_2 + 2H^+ + 2e^{(-)} \rightarrow H_2O$ OR $O_2 + 4H^+ + 4e^{(-)} \rightarrow 2H_2O$ ALLOW Reversible arrows Equations in other direction Electrons subtracted on LHS of first equation Multiples Ignore state symbols even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
20 (a)(ii)	$½O_2 + 2H^+ + 2Fe^{2+} \rightarrow 2Fe^{3+} + H_2O$ OR $O_2 + 4H^+ + 4Fe^{2+} \rightarrow 4Fe^{3+} + 2H_2O$ ALLOW Multiples Reversible arrows Ignore state symbols even if incorrect No TE from 20(a)(i)	Equation in the wrong direction, even with reversible sign	1

Question Number	Acceptable Answers	Reject	Mark
20 (b)(i)	$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$ Ignore state symbols even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
20 (b)(ii)	(Pale) pink	Purple / mauve	1

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Question Number	Acceptable Answers	Reject	Mark
* 20 (b)(iii)	Amount of MnO_4^- = 24.90 x 0.0195 x 10^{-3} = 4.8555 x 10^{-4} (mol)* (1) Amount of Fe^{2+} = answer * x 5 in 25 cm^3 = 4.8555 x 10^{-4} x 5 = 2.42775 x 10^{-3} (mol) So in 250 cm^3 = 2.42775 x 10^{-2} (mol) (1) (M_r ($FeSO_4.7H_2O$) = 277.9) ROUTE 1 (via moles) Amount of Fe^{2+} used to prepare the solution = 6.90 / 277.9 = 2.4829 x 10^{-2} (mol) (1) EITHER % of Fe^{2+} remaining at titration = 100 x 2.42775 x 10^{-2} / 2.4829 x 10^{-2} = 97.7785 (%) (1) % Oxidized = 100 − 97.7785 = 2.221 (%) (1) OR Amount oxidized = 2.4829 x 10^{-2} − 2.42775 x 10^{-2} = 5.516 x 10^{-4} (mol) (1) % Oxidized = 5.516 x 10^{-4} x 100 / 2.4829 x 10^{-2} = 2.221 (%) (1) ROUTE 2 (via mass) mass from titration = 2.42775 x 10^{-2} x 277.9 = 6.7467 (g) (1) % of Fe^{2+} remaining at titration = 100 x 6.7467 / 6.9 = 97.7785 (%) (1) % Oxidized = 100 − 97.7785 = 2.221 (%) (1) Ignore SF except 1 SF unless justified in b(iv) Correct answer no working scores 5 marks 90.22% obtained from failure to multiply by 10 scores 4 marks		5

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Question Number	Acceptable Answers	Reject	Mark
20 (b)(iv)	3 (significant figures) because all the data (except A_r(H)) is given to 3 SF OR 2 (significant figures) because the least precise data (A_r(H)) is 2 SF OR 2 (significant figures) because the data is to three figures. After processing only two figures are certain. OR 1 (significant figure) because of the subtraction of two similar numbers.		1

Question Number	Acceptable Answers	Reject	Mark
20 (c)(i)	Alkali neutralizes the acid shifting the equilibrium to the left OR Alkali neutralizes the acid so E value for half cell becomes less (than +2.20 V) ALLOW 'Reacts with' and 'removes' for 'neutralizes' IGNORE Just "shifts equilibrium to the left"		1

Question Number	Acceptable Answers	Reject	Mark
20 (c)(ii)	$4Fe^{3+} + 4H_2O \rightarrow 3Fe^{2+} + FeO_4^{2-} + 8H^+$ OR Multiples Species (1) balance (1) Ignore state symbols even if incorrect		2

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Question Number	Acceptable Answers	Reject	Mark
20 (c)(iii)	Required half cell value is $E^{\ominus}$ = (+)0.77 (1) $E^{\ominus}_{cell}$ = (0.77 – 2.20 =) −1.43 V ($E^{\ominus}_{cell}$ negative so disproportionation) not feasible (1) TE on calculated negative value of $E^{\ominus}_{cell}$ No TE on positive value for $E^{\ominus}_{cell}$ OR Correct application of anti-clockwise rule e.g. $Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$ $E^{\ominus}$ = +0.77 V $FeO_4^{2-}(aq) + 8H^+(aq) + 3e^- \rightleftharpoons Fe^{3+}(aq) + 4H_2O(l)$ $E^{\ominus}$ =+2.20 V Equations in order of increasing $E^{\ominus}$ value and arrows shown (1) Anti-clockwise rule shows top reaction moves left and bottom reaction moves right so disproportionation not feasible (1)		2

Total for Question 20 = 15 marks

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Question Number	Acceptable Answers	Reject	Mark
21 (a)	(A transition metal) forms ions / oxidation states with partially filled / incomplete d orbital(s) / d sub-shell		1

Question Number	Acceptable Answers	Reject	Mark
21 (b)(i)	W = chromate(VI) (ion) / CrO_4^{2-} (1) X = chromium(III) hydroxide / $Cr(OH)_3$ / $Cr(OH)_3(H_2O)_3$ (1) Y = hexahydroxochromate(III) (ions) / $[Cr(OH)_6]^{3-}$ /tetrahydroxochromate(III) (ions) / $[Cr(OH)_4]^-$ / $[Cr(H_2O)_2(OH)_4]^-$ (1) Z = chromium(II) (ions) / chromium(II) sulfate / Cr^{2+} / $Cr^{2+}(aq)$ / $[Cr(H_2O)_6]^{2+}$ (1) ALLOW Name or formula of the compounds IGNORE Omission of square brackets around complexes	Names without oxidation numbers.	4

Question Number	Acceptable Answers	Reject	Mark
21 (b)(ii)	A = ethanol / C_2H_5OH / ethanal / CH_3CHO OR any primary or secondary alcohol or any aldehyde (1) B = zinc / Zn ALLOW magnesium / Mg (1) C = any acid (name or formula) (1) IGNORE Omission of (aq) with acid formula Concentration of acid	CH_3COH Alkali metals Tin / Sn H^+ or H_3O^+ or acid	3

Question Number	Acceptable Answers	Reject	Mark
21 (b)(iii)	$Cr_2O_7^{2-} + 2OH^- \rightarrow 2CrO_4^{2-} + H_2O$ OR Multiples Ignore state symbols even if incorrect		1

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Question Number	Acceptable Answers	Reject	Mark
21 (b)(iv)	$(NH_4)_2Cr_2O_7 \rightarrow Cr_2O_3 + N_2 + 4H_2O$ Allow multiples (1) Chromium is reduced from (+)6 to (+)3 (1) Nitrogen is oxidized from −3 to 0 (1) Penalise use of 'changes' / 'increases' / 'decreases' for 'oxidises' or 'reduces' once only		3

Question Number	Acceptable Answers	Reject	Mark
21 (b)(v)	(chromium(II) ions) oxidized by (oxygen in the) air ALLOW Just 'oxygen'		1

Question Number	Acceptable Answers	Reject	Mark
21 (c)(i)	(A ligand is a) molecule or (negative) ion with a (lone) pair (of electrons) ALLOW Species / Compound / group (1) Which forms a dative covalent bond with a (central) metal ion or atom (to form a complex) (1) ALLOW (if no other marked scored) Electron pair donor	Positive ion	2

Question Number	Acceptable Answers	Reject	Mark
21 (c)(ii)	$Cr(H_2O)_6^{3+} + 6NH_3 \rightarrow Cr(NH_3)_6^{3+} + 6H_2O$ ALLOW $Cr(H_2O)_6^{3+} + 4NH_3 \rightarrow Cr(NH_3)_4(H_2O)_2^{3+} + 4H_2O$ Correct formula for ammine (1) Rest of the equation correct (1)	Cr^{3+} and $Cr^{3+}(aq)$	2

Total for Question 21 = 17 marks

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Question Number	Acceptable Answers	Reject	Mark
22 (a)(i)	$HNO_3 + 2H_2SO_4 \rightarrow H_3O^+ + 2HSO_4^- + NO_2^+$ OR $HNO_3 + H_2SO_4 \rightarrow H_2O + HSO_4^- + NO_2^+$ OR 2-step version of these involving $H_2NO_3^+$ Correct electrophile (1) correct equation(s) (1)		2

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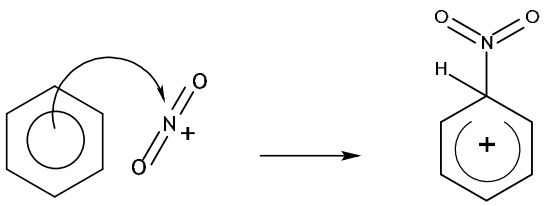
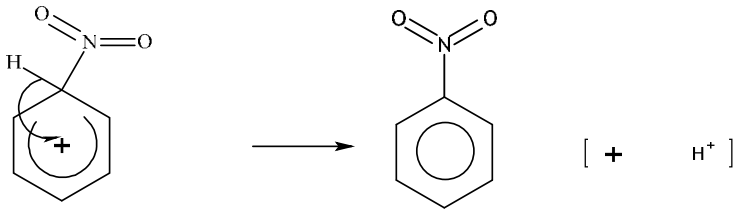
Question Number	Acceptable Answers	Reject	Mark
22 (a)(ii)	  [+ H^+] OR NO_2^+ as electrophile TE on incorrect electrophile in (a)(i) Curly arrow from on or within the circle to positively charged nitrogen ALLOW Curly arrow from anywhere within the hexagon Arrow to any part of the electrophile including to the + charge (1) Intermediate structure including charge with horseshoe covering at least 3 carbon atoms, and facing the tetrahedral carbon and with some part of the positive charge within the horseshoe (1) Curly arrow from C—H bond to anywhere in the benzene ring reforming delocalized structure (1) Correct Kekulé structures score full marks Ignore any involvement of anion in the final step		3

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Question Number	Acceptable Answers	Reject	Mark
22 (a)(iii)	Benzene ring in phenol has higher electron density ALLOW O / OH donates electron density to the (benzene) ring (1) Because lone pair of electrons on (phenol) oxygen is donated to / overlaps with / interacts with (π electrons of benzene) ring (1)		2

Question Number	Acceptable Answers	Reject	Mark
22 (a)(iv)	Substitution may also occur at the 2 / 6 ring positions / ortho position ALLOW 'other' / 3 / 5 / meta ring positions / isomers ALLOW further substitution occurs IGNORE By-products formed		1

Question Number	Acceptable Answers	Reject	Mark
22 (a)(v)	Tin /Sn & (conc.) hydrochloric acid / HCl(aq) ALLOW Iron/ Fe for tin ALLOW HCl for HCl(aq)	$LiAlH_4$ / $NaBH_4$	1

Question Number	Acceptable Answers	Reject	Mark
22 (a)(vi)	Yield = (100 x 0.25 x 0.74 x 0.85) = 15.725 / 15.73 / 15.7 / 16 (%)	16.0 and other rounding errors	1

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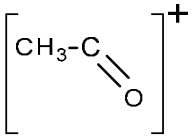
Question Number	Acceptable Answers	Reject	Mark
22 (b)(i)	Insoluble impurities are removed by the hot filtration (1) Soluble impurities are removed by the cold filtration (1)		2

Question Number	Acceptable Answers	Reject	Mark
22 (b)(ii)	5ºC and 95ºC (1) Because the lowest proportion (ALLOW 'amount') of paracetamol remains in solution (at the end) (1) IGNORE Just 'greatest difference in temperature'		2

Question Number	Acceptable Answers	Reject	Mark
22 (b)(iii)	Measure melting temperature ALLOW TLC (with UV light) Ignore Must melt over range of 2ºC Data = data book value	Boiling temperature HPLC	1

Question Number	Acceptable Answers	Reject	Mark
22 c(i)	Peak at m/e = 151 clearly labelled M ALLOW Alternative labels		1

Question Number	Acceptable Answers	Reject	Mark
22 c(ii)	43 =  OR CH_3CO^+ / $C_2H_3O^+$ ALLOW $CONH^+$ Ignore position of charges	$C_3H_7^+$ uncharged species	1

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Question Number	Acceptable Answers	Reject	Mark
22 (d)	Limit number of tablets sold OR Give (oral) advice at the point of sale OR Use packs with tablets individually wrapped ALLOW Reduce the (tablet) dose	Only sell on prescription / doctor's advice Label packet	1

Total for Question 22 = 18 marks

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Section C

Question Number	Acceptable Answers	Reject	Mark
23 (a)(i)	ethanol has hydrogen bonding (as well as London / dispersion (allow van der Waals) forces) (1) ethoxyethane has van der Waals forces only / London forces and dipole-dipole forces / mainly London forces (1) so more energy is needed to separate ethanol molecules than ethoxyethane (molecules) ALLOW Hydrogen bonding is stronger (1)	London forces only	3

Question Number	Acceptable Answers	Reject	Mark
* 23 (a)(ii)	Any three of 1. 1 m cars sounds large but represents a small proportion of global cars 2. industrial / domestic power sources produce more man-made CO_2 3. Side-effects of alternative anaesthetics 4. Unacceptable not to use anaesthetics 5. Possibility of capturing anaesthetics at point of use 6. Possibility of using a different type of anaesthetic		3

Question Number	Acceptable Answers	Reject	Mark
23 (a)(iii)	C–F bonds much stronger (than C–H bonds) (1) Desflurane remains in the atmosphere for longer (and so act as a greenhouse gas, because it is stable) (1)		2

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Question Number	Acceptable Answers	Reject	Mark
* 23 (b)	(A base is a proton acceptor) Basicity due to lone pair (of electrons) on the nitrogen(s) (1) Stand Alone Mark EITHER Lone pair of the nitrogen bonded to the benzene ring is much less basic (1) Because lone pair of the nitrogen bonded to the benzene ring interacts with / overlaps the π electrons of the ring (1) OR lone pair of nitrogen bonded to the alkyl groups more basic (1) Because of the positive inductive effect of the (three) alkyl groups (1)		3

Question Number	Acceptable Answers	Reject	Mark
23 (c)(i)	Equilibrium mixture is formed (so yield is low) ALLOW Reversible reaction IGNORE Rates The ammonium salt of the ester would be formed	Just 'yield is low' Reaction does not go to completion	1

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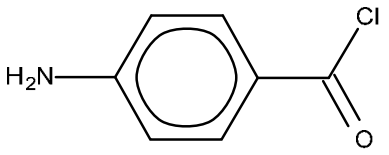
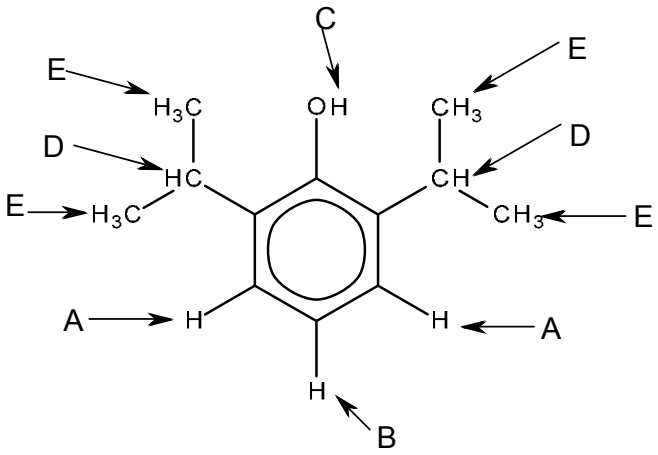
Question Number	Acceptable Answers	Reject	Mark
23 (c)(ii)	PCl_5 /phosphorus(V) chloride / phosphorus pentachloride / PCl_3 /phosphorus(III) chloride / phosphorus trichloride / $SOCl_2$ / thionyl dichloride / thionyl chloride (1) Intermediate is 4-aminobenzoyl chloride /  (1) Add ethanol (1) Third mark dependent on the second (or near miss) If final structure is given, it must be correct	Ethanol and acid	3

Question Number	Acceptable Answers	Reject	Mark
23 (d)(i)	 Score a peak fully correct if all associated protons are correctly identified and none is incorrectly identified. All 5 peaks correct (3) Any 3 or 4 correct (2) Any 2 correct (1)		3

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Question Number	Acceptable Answers	Reject	Mark
23 (d)(ii)	In HPLC there will be one peak for each component of the mixture OR In HPLC there would only be one peak if pure (1) In nmr the peaks due to impurities are more likely to be hidden by peaks of the main compound / indistinguishable from background noise (1)		2

Total for Question 23 = 20 marks
Total for Section C = 20 marks

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