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Mark Scheme (Results)
June 2010

GCE

GCE Chemistry (6CH05/01)

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Section A

Question Number	Correct Answer	Mark
1	D	**1**

Question Number	Correct Answer	Mark
2	C	**1**

Question Number	Correct Answer	Mark
3	A	**1**

Question Number	Correct Answer	Mark
4	A	**1**

Question Number	Correct Answer	Mark
5	C	**1**

Question Number	Correct Answer	Mark
6	A	**1**

Question Number	Correct Answer	Mark
7	C	**1**

Question Number	Correct Answer	Mark
8	B	**1**

Question Number	Correct Answer	Mark
9	A	**1**

Question Number	Correct Answer	Mark
10	D	**1**

Question Number	Correct Answer	Mark
11	B	**1**

Question Number	Correct Answer	Mark
12	D	**1**

Question Number	Correct Answer	Mark
13	C	**1**

Question Number	Correct Answer	Mark
14	A	**1**

Question Number	Correct Answer	Mark
15	A	**1**

Question Number	Correct Answer	Mark
16	B	**1**

Question Number	Correct Answer	Mark
17	B	**1**

Question Number	Correct Answer	Mark
18	C	**1**

Question Number	Correct Answer	Mark
19	B	**1**

Question Number	Correct Answer	Mark
20	D	**1**

Section B

Question Number	Acceptable Answers	Reject	Mark
21 (a)(i)	**Copper:** 0 to +2/2+/2^+/II/2 **(1)** **Nitrogen:** +5/5+/5^+/V/5 to +4/4+/4^+/IV/4 **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	$Cu \rightarrow Cu^{2+} + 2e^{(-)}$ OR $Cu - 2e^{(-)} \rightarrow Cu^{2+}$ **(1)** $Cu[(H_2O)_6]^{2+}$ OK if 6 waters shown on l.h.s. $NO_3^- + 2H^+ + e^{(-)} \rightarrow NO_2 + H_2O$ OR $2NO_3^- + 4H^+ + 2e^{(-)} \rightarrow 2NO_2 + 2H_2O$ **(1)** OR $2NO_3^- + 4H^+ + 2e^{(-)} \rightarrow N_2O_4 + 2H_2O$ **(1)** Ignore the full equation if it is given as well Allow equations written as reverse of above Ignore state symbols even if wrong Allow $\rightleftharpoons$ for $\rightarrow$		**2**

Question Number	Acceptable Answers	Reject	Mark
21(a)(iii)	(electrode potential) values are for standard conditions **(1)** **nitric acid** is concentrated / not 1 mol dm^{-3} / not 1 M **(1)** Allow temperature not stated for second mark	NO_3^- are not 1 mol dm^{-3} Any reference to loss of NO_2	**2**

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	initially a (pale/light) **blue precipitate (1)** Allow blue solid Ignore white precipitate (re-dissolves in excess to form) a (deep) blue **solution (1)** Stand alone mark Accept any shade of blue except greenish-blue	 Any colour (other than blue) precipitate in blue solution	**2**

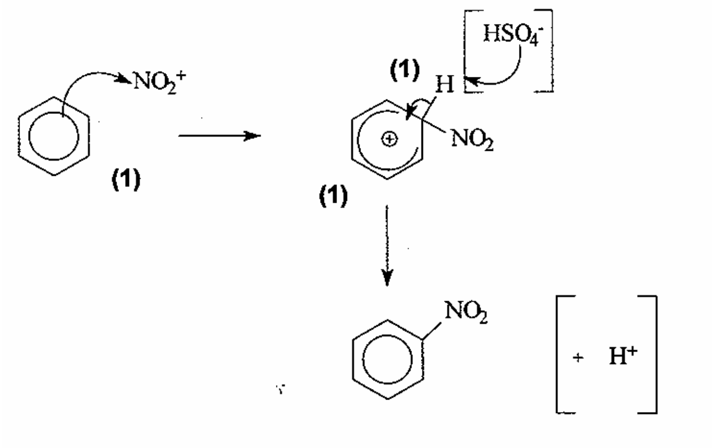
Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	$Cu^{2+}(aq) + 2OH^{-}(aq) \rightarrow Cu(OH)_2(s)$ **(1)** $Zn^{2+}(aq) + 2OH^{-}(aq) \rightarrow Zn(OH)_2(s)$ **(1)** $Zn(OH)_2(s) + 2OH^{-}(aq) \rightarrow Zn(OH)_4^{2-}(aq)$ **(1)** If two previous equations combined correctly then **(1)** only : $Zn^{2+} + 4OH^{-} \rightarrow Zn(OH)_4^{2-}$ **Allow** $Zn(OH)_2(s) + 2OH^{-}(aq) \rightarrow ZnO_2^{2-}(aq) + 2H_2O(l)$ OR $Zn(OH)_2(s) + 4OH^{-}(aq) \rightarrow Zn(OH)_6^{4-}(aq)$ OR equivalent non-ionic equations, including those with Zn^{2+} + 2NaOH etc OR Correct balanced equations starting with hexaqua or tetraqua cations ALLOW the hydroxides to be shown as e.g. $Zn(OH)_2(H_2O)_4$ (s) provided that the whole equation balances. Penalise missing /incorrect state symbols on product once only. Ignore other state symbols		**3**

Question Number	Acceptable Answers	Reject	Mark
21(b)(iii) QWC	**First 2 marks:** zinc **hydroxide/oxide** amphoteric because it reacts with alkali (to give a solution of a zincate) **(1)** and reacts with acid (to give a salt) **(1)** zinc hydroxide **is / acts as** both an acid and an alkali – scores **(1)** only **Third mark:** hexaquazinc or hydrated zinc ions exchanged water for ammonia or other named ligand **(1)** OR $Zn(H_2O)_6{}^{2+} + 4NH_3 \rightarrow$ etc **(1)** Allow any number of ammonias from 1 to 6 Allow balanced equations, ionic or full. Ligand exchange reaction must start with a complex ion **Note:** If zinc mentioned initially but equation refers to a correct compound then credit should be given If equations wrong but words are correct then ignore equations	Reference to zinc ions or zinc metal Do not allow deprotonation	**3**

Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$ Ignore state symbols even if wrong.	Non-ionic equation.	**1**

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii) QWC	Amount thiosulphate = 0.0331 dm^3 x 0.1 mol dm^{-3} = 0.00331 mol **(1)** **=** amount of copper(II) ions in 25 cm^3 portion **(1)** ∴ amount Cu = 10 x 0.00331= 0.0331 mol in total **(1)** ∴ mass Cu = 0.0331 mol x 63.5 g mol^{-1} **(1)** **=** 2.102 g ∴ % copper = (2.102 x 100)÷ 3.00 **(1)** **=** 70.1% **(1)** to **3 s.f. only** Mark consequentially but if % > 100 then (-1) If equation in (i) is incorrect but used correctly in part (ii) then all marks can be scored unless answer > 100% Correct answer can score 6 marks irrespective of the stoichiometry of the equation in (c)(i) If candidates uses 64 for molar mass of Cu final answer will be 70.6; scores max of 5	70.06 or 70.0	**6**

Question Number	Acceptable Answers	Reject	Mark
21(c)(iii)	some reagent used to fill the jet (which does not react with the iodine solution) **and so** the titre is too high **(1)** and hence the percentage value would be too high **(1)** Allow only if the titre is said to be high If the titre is thought to be too low then allow percentage value too low for 2nd mark **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	$H_2SO_4 + HNO_3 \rightarrow NO_2^+ + H_2O + HSO_4^-$ OR $H_2SO_4 + HNO_3 \rightarrow H_2NO_3^+ + HSO_4^-$ $H_2NO_3^+ \rightarrow NO_2^+ + H_2O$ Both needed OR $2H_2SO_4 + HNO_3 \longrightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$ **(1)** Ignore state symbols even if wrong  arrow showing attack on the nitronium ion with arrow going to N atom, or into the C – N gap **(1)** Arrow must start at or inside ring Ignore position of + charge structure of the intermediate showing reasonable delocalisation (over at least 3 carbon atoms) **(1)** arrow **from the bond** showing the loss of H^+ from the intermediate. Removal by hydrogen sulphate ion preferable but not essential **(1)** Kekulé structures score full marks If the electrophile is incorrect then the intermediate structure mark is lost	Delocalisation mustn't go over C where NO_2^+ is attached	**4**

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii) QWC	**First mark:** (lone pair of) electrons on the oxygen atom or on the OH group is delocalised / incorporated into the ring **(1)** OR the OH group is electron donating **(1)** **Second mark:** so the ring in phenol is more negative / has increased electron density / **ring** is more nucleophilic / hence more susceptible to electrophilic attack **(1)** OR the OH group activates the ring **(1)** Second mark stand alone	Reject hydroxide for first mark only Nucleophilic attack on the ring 'Makes it more reactive' on its own	**2**

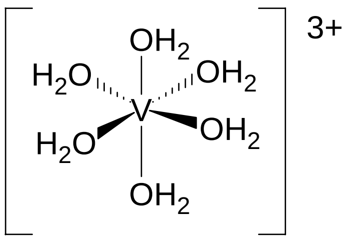
Question Number	Acceptable Answers	Reject	Mark
22(a)(iii)	tin **(1)** and **concentrated** hydrochloric acid **(1)** Formulae acceptable. If NaOH is added after HCl then ignore; if implication that HCl and NaOH are added together then second mark is lost OR iron **(1)** and **concentrated** hydrochloric acid **(1)** **2nd mark conditional on a metal** OR hydrogen **(1)** and platinum / palladium catalyst **(1)**	lithium aluminium hydride sodium borohydride Nickel Raney Nickel	**2**

Question Number	Acceptable Answers	Reject	Mark
22(a)(iv)	ethanoyl chloride OR acetyl chloride OR CH_3COCl OR equivalent displayed formula OR ethanoic anhydride OR acetic anhydride OR $(CH_3CO)_2O$ OR equivalent displayed formula Right name but wrong formula does not score Ignore minor spelling errors if the formula is correct		**1**

Question Number	Acceptable Answers	Reject	Mark
22(b) **QWC**	**First mark:** steam is passed into the mixture OR water is added and mixture boiled or distilled or heated **(1)** **Second mark:** and the 2-nitrophenol / product vapour distilled off **with the water** (and condensed) **(1)** **Advantage:** The 2-nitrophenol / product distils at a lower temperature / prevents decomposition**(1)** Stand alone	Passed over; anything that implies external heating with a steam bath or water bath any implication of fractional distillation any suggestion that separation based on differing boiling temperature water-soluble	**3**

Question Number	Acceptable Answers	Reject	Mark
22(c)	Read the whole answer to get the sense The (ring) hydrogen atoms are on carbon atoms which have **one / a** hydrogen on an **adjacent** carbon atom, so are doublets **(1)** All the other hydrogen atoms have no adjacent hydrogen (bearing carbon) atoms, so are singlets **(1)**	nearby	**2**

Question Number	Acceptable Answers	Reject	Mark
23(a)(i)	Any TWO of: complex ions / complexes **(1)** coloured ions / compounds / solutions **(1)** catalytic properties **(1)** paramagnetic **(1)** Allow coloured complexes **(2)** coloured complex compound **(1)** If a list appears with 1 or 2 correct properties followed by properties related to the element, then (1) mark only Ignore 'partially filled *d*-orbitals'	 complex compounds	**2**

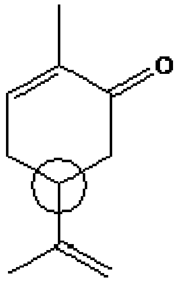
Question Number	Acceptable Answers	Reject	Mark
23(a)(ii)	 ignore absence of charge **clearly** octahedral (ignore bonds to the H in H_2O) **(1)** but allow some latitude in the symbols used to show the 3D structure. Wedges do not have to be exact – if used they are enough to show 3D if the axial bonds are lines The word 'octahedral' does not salvage a poor drawing dative (covalent) / coordinate (bond) **(1)** not just shown by an arrow lone pair (of electrons on the oxygen) **(1)** can be shown on the diagram		**3**

Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	(+) 0.34 (V) OR (+) 0,34 V sign not needed		**1**

Question Number	Acceptable Answers	Reject	Mark
23(b)(ii) QWC	(simultaneous) oxidation and reduction **(1)** Allow redox of a species / substance / reactant / compound / chemical / element **(1)**		**2**

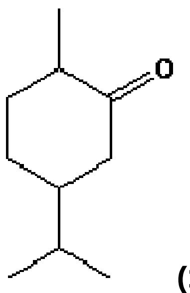
Question Number	Acceptable Answers	Reject	Mark
23(b)(iii)	− 0.66(V) **(1)** Allow TE from (b)(i) reaction not feasible **since the potential is negative** (2nd mark is for an answer consistent with sign of E°) **(1)**		**2**

Section C

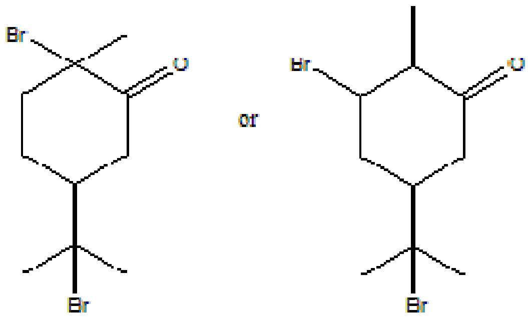
Question Number	Acceptable Answers	Reject	Mark
24(a)		Circles that encompass two atoms	**1**

Question Number	Acceptable Answers	Reject	Mark
24(b)	**First mark:** Recognition that paracetamol is not chiral / has no enantiomers / does not have optical isomers **(1)** **Second and third marks:** Any two of: there is no racemisation so the product will not be a mixture **(1)** no need to separate (the enantiomers) **(1)** do not have to discard an unwanted enantiomer / atom economy is higher **(1)** **OR** converse arguments starting from (-)-carvone.	Is not optically active	**3**

Question Number	Acceptable Answers	Reject	Mark
24(c)	(C=C): add bromine (water) **(1)** decolourises **(1)** OR $KMnO_4$ **(1)** purple → brown / colourless **(1)** (C=O): add 2,4-dnp / 2,4-dinitrophenylhydrazine/ Brady's reagent **(1)** orange or yellow or orange-red or red ppt **(1)** Ignore a negative Fehling's / Tollens' test If a positive Fehling's / Tollens' is given in addition to 2,4 DNP then third and fourth marks are lost Observation dependent on test	1,4-dnp	**4**

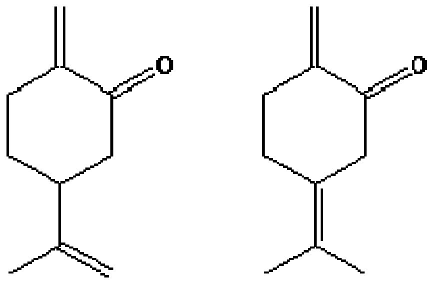
Question Number	Acceptable Answers	Reject	Mark
24(d)(i)	amount of carvone = (4.5 ÷ 150) mol = 0.03 mol **(1)** amount of hydrogen = (1.44 ÷ 24) mol = 0.06 mol (allow 1st mark for either of the mole calculations) so two double bonds are reduced **(1)** OR 2 moles H_2 : (1 mol carvone) OR 4 mole H : (1 mol carvone) If hydrogen is used it must be clear whether they are atoms or molecules This mark can be salvaged if the structure is correct and both double bonds are reduced  **(1)** stand alone Accept displayed formula if completely correct	Any structure that shows reduction of the C=O bond	**3**

Question Number	Acceptable Answers	Reject	Mark
24(d)(ii)	(a ketone/C=O) absorption / peak / trough / within the range 1680 – 1700 (cm^{-1}) **(1)** Ignore units will be seen in carvone but not in limonene / the reduction product **(1)** omission of the value for the absorption loses first mark only	1720 - 1740 cm^{-1}	**2**

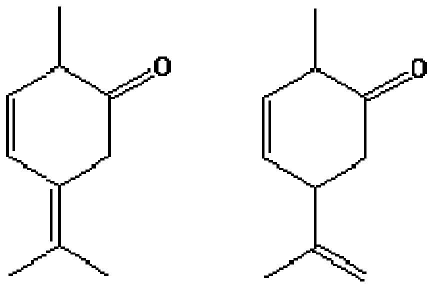
Question Number	Acceptable Answers	Reject	Mark
24(e)(i)	 for both double bonds having HBr added **(1)** ignore added hydrogens for correct orientation in **exocyclic** double bond **(1)** stand alone	Any structure retaining C=C bonds	**2**

Question Number	Acceptable Answers	Reject	Mark
24(e)(ii)	HBr can be eliminated using a hydrogen from the carbon on either side of the bromine **(1)** which would then give a double bond in a different position from that in carvone **(1)** this second mark can be answered using a skeletal / structural formula (below)	Reference to substitution	**2**

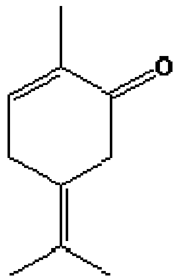
From the left-hand structure above:



From the right-hand structure above:



From either of the structures above:



Question Number	Acceptable Answers	Reject	Mark
24(f)(i) QWC	**Using an S_N1mechanism:** selection of a chiral starting material **(1)** curly arrow from C-X bond to X **(1)** and intermediate carbocation **(1)** curly arrow from nucleophile (can come from negative charge) **(1)** **planar intermediate** attacked from either side to give a racemic mixture **OR** **intermediate equally** attacked from either side to give a racemic mixture **(1)** **Using an S_N2 mechanism:** selection of a chiral starting material **(1)** curly arrow from nucleophile (can come from negative charge) **(1)** curly arrow from C-X bond to X **(1)** to give correct transition state **(1)** attack from opposite side to C-X bond gives inverted product can be shown on a diagram **(1)** **Using nucleophilic addition to C= O:** Selection of any aldehyde (other than methanal) or any asymmetric ketone **(1)** Curly arrow from nucleophile (can come from negative charge) to C of C=O and curly arrow from = to O **(1)** Intermediate **(1)** Arrow from O^- of intermediate to H^+ **(1)** **planar molecule** attacked from either side to give a racemic mixture **OR** **molecule equally** attacked from either side to give a racemic mixture **(1)**	 If H-X used then -1	**5**

Question Number	Acceptable Answers	Reject	Mark
24(f)(ii)	heterogeneous catalysts can be filtered off OR do not appear in any liquid or gaseous products OR are easy to separate OR are stereospecific OR suited to continuous processes rather than batch processes	greater surface area	**1**

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