

Mark Scheme (Final)

June 2009

GCE

GCE Chemistry (6256/01)

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

- 1 / means that the responses are alternatives and either answer should receive full credit.
- 2 () 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.
- 3 [] words inside square brackets are instructions or guidance for examiners.
- 4 Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
- 5 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.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- show clarity of expression
- construct and present coherent arguments
- demonstrate an effective use of grammar, punctuation and spelling.

Full marks will be awarded if the candidate has demonstrated the above abilities.

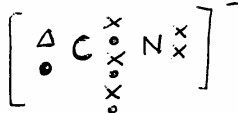
Questions where QWC is likely to be particularly important are indicated "QWC" in the mark scheme BUT this does not preclude others.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	$6\text{Fe}^{2+}(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) \rightarrow 6\text{Fe}^{3+}(\text{aq}) + 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$ 6 Fe^{2+} and 6 Fe^{3+} (1) rest of equation (1) Mark independently			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark	
1 (a)(ii)	Moles of dichromate $= 19.8/1000 \times 0.02$ (1) $= 3.96 \times 10^{-4}$ Moles of $\text{Fe}^{2+} = 19.8/1000 \times 0.02 \times 6 = 2.376 \times 10^{-3}$ Mass of Fe = $2.376 \times 10^{-3} \times 55.9 = 0.1328184$ (g) (1) % purity = $0.1328184/0.149 \times 100 = 89.140$ %(1) accept 2 to 5 sf Correct answers with or without working 3 marks	To obtain 2 nd and 3 rd marks they must be derived from stoichiometry in (a)(i) TE from incorrect stoichiometry can get full marks A _r (Fe) of 56 giving mass = 0.133056g % purity = 89.299% if Moles of $\text{Fe}^{2+} = 2.4 \times 10^{-3}$ this gives % as 90.20 if 56 or 90.04 if 55.9 if Moles of $\text{Fe}^{2+} = 2.38 \times 10^{-3}$ this gives % as 89.450 if 56 or 89.290 if 55.9		% Iron > 100%	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iii)	Manganate / MnO_4^- / It could oxidise / react with chloride ions (to give chlorine) (1) EITHER \ominus Because E ^o of MnO_4^- \ominus (+1.51V) is more positive than E ^o of Cl^- (+1.36V) / application / consistent with / of anti-clockwise rule(1) OR Correct explanation of effect on purity Second mark dependent on the first	chlorine ions / hydrochloric acid / HCl	MnO_4^- could reduce chloride (to chlorine) Quoting values on their own does not score a mark	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	Octahedral (1)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	 <p>Do not penalise lack of brackets nor missing sign</p>	<p>All dots/crosses</p> <p>'lone pairs' can be separate</p>	Positive sign	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	<p>Monodentate / unidentate (1)</p> <p>Forms dative / coordinate (covalent) bond</p> <p>OR</p> <p>Bonds attached using lone pair (from N or C) (1)</p> <p>Mark independently</p>	Ignore lone pairs	<p>Covalent on its own</p> <p>bonds with pairs of electrons</p>	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i) QWC	It is seven coordination / forms seven bonds / it has more than 6 points of attachment to ligands / edta is not using all 6 points of attachment (1)		<p>7 ligands</p> <p>2 different ligands</p> <p>Just stating edta is hexadentate and water is monodentate</p>	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	<p>[Fe(edta)H₂O]⁻</p> <p>as when it forms, 3 particles / molecules / ions produce seven/increased number of particles (1)</p> <p>giving a (large) positive value / increase for the entropy (change) (of the system) (1)</p>	<p>If numbers used must be either 2 → 7 or 3 → 7 / Increase of 5 or 4</p>	<p>Energetically favourable on its own with no mention of entropy</p> <p>Increase in entropy without any justification insufficient for 2nd mark</p>	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)(i)	<p>Pt Fe²⁺(aq), Fe³⁺(aq) [O₂(g) + 4H⁺(aq)], 2H₂O(l) Pt (1) Must have state symbols square brackets must be in correct place Commas needed.</p>	<p>Written either way round Salt bridge can be shown in a variety of ways Allow [4H⁺(aq) + O₂(g)]</p>		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)(ii)	<p>1.23 - 0.77 = +0.46 (V) (1) Ignore positive sign if working shows it to be positive Sign of E_{cell}[⊖] must match the cell diagram in part (i) equilibrium in which Fe³⁺ ions or products predominate / almost goes to completion / equilibrium lies well to the rhs / not complete as E[⊖] < 0.6V(1) 2nd mark can be gained by TE from incorrect E[⊖] value</p>	<p>-0.46 (V) if cell diagram reversed</p>	<p>0.46 with no sign and no working reaction likely to take place goes to completion unless comments on number of electrons transferred equilibrium lies to the right without qualification</p>	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)(iii)	<p>O₂ + 4H⁺ + 4Fe²⁺ → 2H₂O + 4Fe³⁺ Reactants and products (1) Balancing (1) Ignore state symbols 2nd mark dependent on first, unless equation correctly balanced but shown in the wrong direction when this mark can be awarded The direction of the reaction must match the sign in part (ii) unless an equilibrium sign is used when the reactants and products can be on either side</p>	<p>Allow equilibrium sign</p>		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (e) QWC	<p>Reduces activation energy by forming (activated) complex with nitrogen or hydrogen OR activation energy lowered because hydrogen or nitrogen or gases / adsorbed / is held/ bonds to/ reacts on surface of iron (1)</p> <p>One from</p> <p>Bond strength between Fe and N₂ or H₂ Cost of catalyst compared with effect on rate Level of impurities in transition metal Likelihood of catalyst poisoning (1)</p>		<p>Any reference to Fe cannot get the first mark</p> <p>Alternative route with lower activation energy on its own cannot get the first mark.</p> <p>Cheapness / abundance of iron on its own</p>	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(i)	Steam distillation prevents decomposition / burning / destroying / degrading of X when heated (1)	Allows product to distil below its bpt /steam breaks bond between oil and bark /distils at a lower temperature	Only organic compounds removed	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii) QWC	<p>Solvent extraction/use of separating funnel to separate X from water/ Use of dropping pipette to remove oily layer (1)</p> <p>Dry solvent & X mixture with named suitable drying agent e.g. silica gel /anhydrous CaCl₂/ anhydrous Na₂SO₄/ anhydrous MgSO₄ (1)</p> <p>(Filter and) distil to remove solvent / re-distil to purify (1)</p>	<p>Ignore references to NaCl (aq) addition</p> <p>Allow 1 mark for redistillation even if rest of method incorrect</p> <p>If first mark for separating and second mark for drying then can obtain third mark for leaving to stand / until clear AND filtering / decanting</p>	<p>Decant</p> <p>CaCO₃ / CoCl₂/CuSO₄ /H₂SO₄</p>	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)	$0.215/18 \times 2 = 0.0239$ mol H (1) $650/24000 = 0.0271$ mol C (1) $[0.397 - (0.0271 \times 12) - 0.0239]/16 = 0.003$ mol O (1) The numbers candidates calculate only need to be correct to 2 s.f. provided correct method shown e.g. moles of H = 0.024 would gain the mark $0.0271/0.003 = 9$, $0.0239/0.003 = 8$, $0.003/0.003 = 1$ hence C ₉ H ₈ O (1) Ignore significant figures Mark all four points independently	Mass of H = 0.0239g (1) Mass of C = 0.3250g (1) Mass of O = 0.0481g (1) The numbers candidates calculate only need to be correct to 2 s.f. provided correct method shown e.g. for mass of oxygen allow any number that corrects to 0.048 so 0.0479 would gain the mark ratio 9:8:1 gains fourth mark if clear which elements they refer to correct empirical formula with no working / incorrect working (1)		4

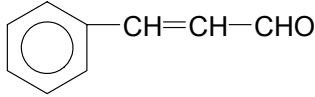
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	Contains a carbon-carbon double bond/alkene (functional group) (1)	Phenol/activated benzene ring	It has double bonds unsaturated	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Contains a carbon-oxygen double bond/ C=O / carbonyl group/aldehyde or ketone (1)		Carboxylic acid Aldehyde or ketone on their own	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(iii)	Contains an aldehyde / alkanal (group) (1)	“Not a ketone” if “aldehyde or ketone” given in (ii)	Aldehyde or alcohol Reducing agent Can be oxidised	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(iv)	Contains benzene (ring) / arene / aromatic /highly unsaturated (1)	(very) high C:H ratio (very) low H:C ratio	High carbon content unsaturated	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(v)	Benzene ring is monosubstituted/has 5 adjacent hydrogens (1)	If benzene ring mentioned in (iv) then just "monosubstituted" or "5 adjacent H atoms" will gain the mark	4 or 5 adjacent hydrogens benzene ring on its own	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	 (1)	-C(CHO)=CH_2 displayed formula (cis or trans) No TE from 2(b) unless an alkene, aldehyde 5 adjacent hydrogens on the benzene ring and matches the empirical formula given in part (b)	-CH=CH-COH	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	<p>Fully labelled cycle of entities/formulae and state symbols. (Allow one missing state symbol)(1)</p> <p>Correct identifiable energy changes OR correct data (1)</p> <p>Multiples not necessary for 2nd mark</p> <p>$[(2 \times 284.6) + (2 \times 731) + (249.2) + (-141.1) + (798)] + LE = -31 (1)$</p> <p>$LE = -2968 \text{ (kJ mol}^{-1}\text{)} (1)$</p> <p>Must have 4 sig figs or mark lost</p>	<p>TE from incorrect data in cycle</p> <p>Correct answer alone = 2 marks</p>	<p>$Ag_2^{2+} O^{2-}$</p> <p>$Ag_2^+ O^{2-}$</p> <p>3rd mark can be given for correct equation using symbols provided multiples included</p>	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	<p>This suggests the bonding model is NOT tending towards covalency / little polarisation (of anion)/ mainly / largely ionic (1)</p> <p>because silver ion is EITHER (quite) large / singly charged / low charge density OR because oxide ion is (quite) small (1)</p>	<p>Ignore charge density of oxide ion</p>	<p>More ionic</p> <p>Completely ionic</p> <p>Purely ionic</p>	2

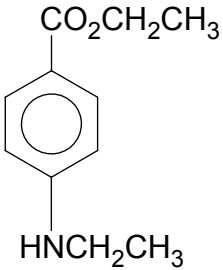
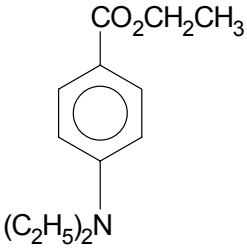
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10}$ (4f ⁰) (1) allow capitals and / or subscripts	[Kr] 4d ¹⁰ [Ar] 3d ¹⁰ 4s ² 4p ⁶ 4d ¹⁰ 3d ¹⁰ 4s ² can be in either order		1

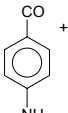
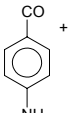
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	They have a full 4d (sub) shell/level/orbital (1)	Does not have an incomplete 4d subshell		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	Electrophilic substitution (1) 2 or more nitro groups OR nitro group in different position OR correct formula or name to show this (1) eg 2-nitrotoluene / 1 - methyl - 2 - nitrobenzene / trinitrotoluene		Nitration Any substance that doesn't contain a nitro group eg water, hydrogen etc	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	does not reduce -COOH/acid group (1)	LiAlH ₄ will reduce / react with / attack the acid group (to form an aldehyde or alcohol) as well as NO ₂ / instead of the NO ₂ group		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iii)	Add copper sulphate / copper ions (solution) (1) Blue/green/brown (precipitate/complex/solution /colour) forms (1)	Any copper compound that contains copper ions Add an acyl chloride(1) and misty (white/steamy) fumes given off (1)	Use of Ninhydrin Nmr Neutralise an acid Add to water and add an indicator	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iv)	Add ethanol (1) Reflux/ (gentle) heat / warm with any acid (name or formula but need not be named) (1) 2 nd mark dependent on reagent given as just alcohol or named alcohol	Add PCl ₅ (1) then ethanol (1)	Alcohol	2
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(v)	 (1) or displayed fully or partly			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)	 C ₇ H ₆ NO ⁺ /  at (120) (1) C ₃ H ₅ O ₂ ⁺ / CO ₂ CH ₂ CH ₃ ⁺ (at 73) (1) Penalise lack of "+" once only	C ₇ H ₄ O ₂ ⁺ at 120		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)	Benzene ring (hydrogen / protons) at 7.8 (1), Methyl/ethyl/alkyl/alkane (hydrogen / protons) at 1.5 (1)		NH/amine/amide hydrogen at 1.5 Alkane and amine	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d) QWC	<p>Suitable solvent (that is able to interact with both hydrophilic and hydrophobic regions) e.g Alcohol / ethanol / any other named alcohol (1)</p> <p>because hydroxyl group can H bond to amine group OR ester group(1)</p> <p>and ethyl group can form (equivalent) vdw forces with benzene ring (1)</p> <p>OR propanone (1) C=O group can H bond to the amine (1) and methyl group can form (equivalent) vdw forces with benzene ring (1)</p>	<p>Diagrams showing correct intermolecular forces</p> <p>If named solvent e.g water can form H bonds with correct groups on benzocaine identified the second mark can be awarded</p> <p>If named solvent e.g hydrocarbon can form vdw forces with benzene ring the third mark can be awarded</p> <p>If no named solvent suggested maximum (2) if hydrophilic and hydrophobic regions of benzocaine identified</p>	<p>Strong acid to form salt</p> <p>Water</p> <p>Dipole dipole interactions</p> <p>Solvent butan-1-ol / ethanoic acid / water mixture</p>	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (e)(i)	Thermal decomposition /Redox / reduction (1)		Disproportionation Oxidation Decomposition	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (e)(ii)	$\text{SnCl}_4 + 4\text{H}_2\text{O} \rightarrow \text{Sn}(\text{OH})_4 + 4\text{HCl}$ OR $\text{SnCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SnO}_2 + 4\text{HCl}$	<p>Instead of 4HCl accept $4\text{H}^+ + 4\text{Cl}^-$</p> <p>Accept multiples</p>		1