

Mark Scheme (Results) January 2011

GCE

GCE Chemistry (6CH05/01)

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Section A (multiple choice)

Question Number	Correct Answer	Mark
1	D	1

Question Number	Correct Answer	Mark
2	C	1

Question Number	Correct Answer	Mark
3	B	1

Question Number	Correct Answer	Mark
4	C	1

Question Number	Correct Answer	Mark
5	B	1

Question Number	Correct Answer	Mark
6	A	1

Question Number	Correct Answer	Mark
7	D	1

Question Number	Correct Answer	Mark
8 (a)	A	1

Question Number	Correct Answer	Mark
8 (b)	D	1

Question Number	Correct Answer	Mark
8 (c)	C	1

Question Number	Correct Answer	Mark
8 (d)	A	1

Question Number	Correct Answer	Mark
9 (a)	C	1

Question Number	Correct Answer	Mark
9 (b)	A	1

Question Number	Correct Answer	Mark
9 (c)	D	1

Question Number	Correct Answer	Mark
10	C	1

Question Number	Correct Answer	Mark
11	A	1

Question Number	Correct Answer	Mark
12 (a)	D	1

Question Number	Correct Answer	Mark
12 (b)	A	1

Question Number	Correct Answer	Mark
13	B	1

Question Number	Correct Answer	Mark
14	D	1

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
15 (a) (i)	Electrophilic substitution (any order)		1

Question Number	Acceptable Answers	Reject	Mark
15 (a) (ii)	$\text{AlCl}_3 + \text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{CH}_3 \rightarrow \text{AlCl}_3\text{Br}^- + \text{CH}_3\text{C}^+\text{HCH}_2\text{CH}_3$ <p>ALLOW $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{CH}_3 \rightarrow \text{Br}^- + \text{CH}_3\text{C}^+\text{HCH}_2\text{CH}_3$ Ignore position of the + for this mark Ignore curly arrows in this equation (1)</p> <p>Electron pair (curly arrow) from ring to positively charged second carbon of carbocation (1)</p> <p>Structure of intermediate must include positive sign (1)</p> <p>Electron pair from C-H bond reforms delocalized ring (1)</p>	AlCl_4^-	4

Question Number	Acceptable Answers	Reject	Mark
15 (b)	<p>Advantage Graphite catalyst easier to remove / separate / can be filtered off (from reaction mixture) / graphite can be re-used (1)</p> <p>Justification AlCl_3 is soluble or graphite is insoluble / different state / different phase</p> <p>OR</p> <p>Graphite can be re-used (1)</p> <p>Mark independently</p>	Just graphite is a heterogeneous catalyst	2

Question Number	Acceptable Answers	Reject	Mark
15 (c) (i)	(Conc) nitric acid (1) (Conc) sulfuric acid (1) penalise dilute once only		2

Question Number	Acceptable Answers	Reject	Mark
15 (c) (ii)	Greater electron density in ring / ring is activated / more susceptible to electrophilic attack (1) Due to electron releasing / donating methyl groups (1)	Just more susceptible to attack	2

Question Number	Acceptable Answers	Reject	Mark
15 (c) (iii)	Reduction ALLOW redox	Hydrogenation	1

Question Number	Acceptable Answers	Reject	Mark
15 (c) (iv)	NaNO ₂ / sodium nitrite / sodium nitrate(III) & HCl (any strong acid) (1) Temp 0-10 °C / less than 10 °C / any quoted temperature between 0 -10 °C / in ice bath (1) $C_6H_3(CH_3)_2NH_2 + HNO_2 + HCl \rightarrow C_6H_3(CH_3)_2N_2^+Cl^- + 2H_2O$ (1) Add phenol dissolved in alkali (1) $(C_6H_3(CH_3)_2N_2^+Cl^- + C_6H_5OH) \rightarrow C_6H_3(CH_3)_2N_2C_6H_4OH + (HCl)$ (1) Mark given for correct organic product Allow correct organic product shown as -O ⁻ instead of -OH Mark independently	HNO ₃	5

Question Number	Acceptable Answers	Reject	Mark
16 (a) (i)	$(\text{COOH})_2 \rightarrow 2\text{CO}_2 + 2\text{H}^+ + 2\text{e}^-$ (1) $\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$ (1)		2

Question Number	Acceptable Answers	Reject	Mark
16 (a) (ii)	$5(\text{COOH})_2 + 2\text{MnO}_4^- + 6\text{H}^+ \rightarrow 10\text{CO}_2 + 2\text{Mn}^{2+} + 8\text{H}_2\text{O}$ ALLOW multiples ALLOW $5(\text{COOH})_2 + 2\text{MnO}_4^- + 16\text{H}^+ \rightarrow 10\text{CO}_2 + 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 10\text{H}^+$ Ignore state symbols even if incorrect	Equation with electrons left in	1

Question Number	Acceptable Answers	Reject	Mark
16 (a) (iii)	Moles of $\text{MnO}_4^- = 11.30/1000 \times 0.010 = 1.13 \times 10^{-4}$ (mol) (1) Moles of $(\text{COOH})_2$ in $10 \text{ cm}^3 = 1.13 \times 10^{-4} \times 5/2 = 2.825 \times 10^{-4}$ (mol) (1) Moles of $(\text{COOH})_2$ in whole sample = $2.825 \times 10^{-4} \times 50 = 0.01412(5)$ (mol) (1) Mass of acid = $0.01412(5) \times 90 = 1.27 \text{ g}$ (1) % in leaves = $1.27/250 \times 100 = 0.51$ (%) (1) If ratio 5 : 2 is not used, maximum (4) e.g. if ratio 2:5 is used then percentage in leaves = 0.08%	TE for 5th mark if % is greater than 100% Rounding errors once in first 4 marks Final answers not quoted to 2 dp	5

Question Number	Acceptable Answers	Reject	Mark
16 (a) (iv)	$\pm 0.05 \text{ cm}^3$ (1) $[(0.05 \times 2) / 11.3] \times 100 = 0.88\%$ (1) ALLOW $\pm 0.025 \text{ cm}^3$ (1) $[(0.025 \times 2) / 11.3] \times 100 = 0.44\%$ (1) ALLOW TE for second mark		2

Question Number	Acceptable Answers	Reject	Mark
16 (a) (v)	Any two from: Only one titration carried out (1) Leaves may contain other substances that MnO_4^- could oxidize/ react with (1) Not all ethanedioic acid extracted from leaves (1) ALLOW temperature too low / below 60°C (1) Different amounts of acid from different leaves (1)	Errors in technique e.g. transfer errors	2

Question Number	Acceptable Answers	Reject	Mark
16 (a) (vi)	(Wearing gloves suggested as) ethanedioic acid is toxic / harmful OR rhubarb leaves are toxic /harmful (1) (Unnecessary because) it is (very) dilute / present in small amounts (1) ALLOW because is not absorbed through the skin Second mark is independent of the first	References to weak acid Rhubarb is toxic	2

Question Number	Acceptable Answers	Reject	Mark
16 (a) (vii)	(Cloudiness due to) MnO_2 (solid /precipitate) (1) Ignore colour of precipitate EITHER Suitable use of E^\ominus (+0.34V) OR MnO_4^- ions are a strong enough oxidizing agent to oxidize Cl^- ions (1)		2

Question Number	Acceptable Answers	Reject	Mark
16 (b) (i)	$(1s^2)2s^22p^63s^23p^63d^5(4s^0)$	$4s^2 3d^3$	1

Question Number	Acceptable Answers	Reject	Mark
16 (b) (ii)	Octahedral		1

Question Number	Acceptable Answers	Reject	Mark
17 (a) (i)	<p>(Ligands cause) d orbitals / sub-shell / sub level to split (1)</p> <p>Some frequencies of light (energy) are absorbed (1)</p> <p>To promote electrons (within d level / d → d transitions) (1)</p> <p>ALLOW as alternative for second mark</p> <p>Remaining light is transmitted / reflected (resulting in the colour seen)</p> <p>Mark independently</p>	Description of flame test	3

Question Number	Acceptable Answers	Reject	Mark
17 (a) (ii)	<p>Concentrated HCl / HCl / HCl (aq) (1)</p> <p>Ligand exchange / replacement / substitution (1)</p> <p>Mark independently</p>	Dilute HCl	2

Question Number	Acceptable Answers	Reject	Mark
17 (b) (i)	$[\text{Cr}(\text{H}_2\text{O})_6]^{3+} + \text{H}_2\text{O} \rightleftharpoons [\text{Cr}(\text{H}_2\text{O})_5(\text{OH})]^{2+} + \text{H}_3\text{O}^+$ <p style="text-align: center;">(1) (1)</p> <p>ALLOW</p> $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} + \text{H}_2\text{O} \rightleftharpoons [\text{Cr}(\text{H}_2\text{O})_5(\text{OH})]^{2+} + \text{H}_2\text{O} + \text{H}^+$ <p style="text-align: center;">(1) (1)</p> <p>ALLOW second mark for number of H₃O⁺ ions related to incorrect complex e.g. [Cr(H₂O)₄(OH)₂]²⁺ + 2H₃O⁺ scores second mark</p> <p>Ignore state symbols even if wrong</p>		2

Question Number	Acceptable Answers	Reject	Mark
17 (b) (ii)	<p>The concentration of oxonium / hydrogen ions is less in the $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ / fewer hydrogen ions produced or reverse argument based on Cr ion (1)</p> <p>ALLOW</p> <p>$[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ / chromium ion deprotonates more easily if H_3O^+ shown in equation in (b) (i)</p> <p>Because copper ion is 2+ whilst the chromium ion is 3+ / charge on copper ion is less than charge on Cr ion / less charge density on 2+ ions / Cr (3+) draws more electron density from the O-H bond (1)</p>	<p>Just chromium complex more acidic</p> <p>The concentration of oxonium / hydrogen ions is greater in the $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ / more hydrogen ions produced</p> <p>Ligand exchange</p>	2

Question Number	Acceptable Answers	Reject	Mark
17 (c)	$\text{Cr}(\text{OH})_3$ / $\text{Cr}(\text{H}_2\text{O})_3(\text{OH})_3$		1

Question Number	Acceptable Answers	Reject	Mark
17 (d)	<p>NaOH is a (strong) base / alkali (1)</p> <p>$\text{Cr}(\text{H}_2\text{O})_3(\text{OH})_3$ loses (three) protons / undergoes further deprotonation</p> <p>OR</p> <p>$\text{Cr}(\text{OH})_3$ is amphoteric (so reacts with strong bases) (1)</p> <p>To reverse reaction 4 add (sulfuric) acid / H^+ / HCl (1)</p>	Chromium is amphoteric	3

Question Number	Acceptable Answers	Reject	Mark
17 (e)	<p>$[\text{Cr}(\text{NH}_3)_6]^{3+} + (\text{edta})^{4-} \rightarrow [\text{Cr}(\text{edta})]^- + 6\text{NH}_3$ (1)</p> <p>Ignore missing brackets</p> <p>Ignore state symbols even if wrong</p> <p>During the reaction number of particles increases (2 to 7) / more moles of product than reactants AND entropy (of system) increases (1)</p>	Entropy increases because a gas is produced only Just more products than reactants	2

TOTAL FOR SECTION B = 50 MARKS

Section C

Question Number	Acceptable Answers	Reject	Mark
18 (a) (i)	<p>Mass of C in CO₂ = $12/44 \times 0.88 = 0.24$ g Mass of H in H₂O = $2/18 \times 0.216 = 0.024$g (1)</p> <p>So mass of oxygen = $0.328 - (0.24 + 0.024) = 0.064$ g (1)</p> <p>Moles of C = $0.24/12 = 0.02$ Moles of H = $0.024/1 = 0.024$ Moles of O = $0.064/16 = 0.004$ (1)</p> <p>Ratio = simplest ratio = 5:6:1 so C₁₀H₁₂O₂ (1)</p> <p>OR Moles of CO₂ = $0.88/44 = 0.02$ Moles of H₂O = $0.216/18 = 0.012$ (1)</p> <p>Moles of H = 0.024 therefore ratio of C:H is 5:6 (1)</p> <p>Can gain remaining two marks if they continue calculation as above</p> <p>OR C₁₀H₁₂O₂ = 164 (1)</p> <p>Percentage carbon is $120/164 = 73.2\%$ Percentage hydrogen is 7.3% Percentage oxygen is 19.5% (1)</p> <p>Mass of carbon = $73.2 \times 0.328/100 = 0.24$ Mass of hydrogen = $7.3 \times 0.328/100 = 0.024$ Mass of oxygen = $19.5 \times 0.328/100 = 0.064$ (1)</p> <p>Mass of carbon in CO₂ is $12/44 \times 0.88 = 0.24$ Mass of hydrogen in H₂O is $1/9 \times 0.216 = 0.024$ (1)</p> <p>OR Mass of C in CO₂ = $12/44 \times 0.88 = 0.24$ g Mass of H in H₂O = $2/18 \times 0.216 = 0.024$g (1)</p> <p>So mass of oxygen = $0.328 - (0.24 + 0.024) = 0.064$ g (1)</p> <p>Percentage of C = $0.24/0.328 = 73.2\%$ Percentage of H = $0.024/0.328 = 7.3\%$ Percentage of O = $0.064/0.328 = 19.5\%$ (1)</p> <p>C₁₀H₁₂O₂ = 164 Percentage carbon is $120/164 = 73.2\%$ Percentage hydrogen is $12/164 = 7.3\%$ Percentage oxygen is $32/164 = 19.5\%$ (1)</p>		4

Question Number	Acceptable Answers	Reject	Mark
18 (a) (ii)	Add (small amount of) Br ₂ / bromine (1) (Br ₂ turns from orange / yellow / red-brown to colourless / decolourised (1) OR Add (small amount of) acidified KMnO ₄ (aq) (1) KMnO ₄ (aq) turns from purple/pink to colourless / brown (1) OR Add (small amount of) alkaline KMnO ₄ (aq) (1) KMnO ₄ (aq) turns from purple/pink to green (1)	clear	2

Question Number	Acceptable Answers	Reject	Mark
18 (a) (iii)	(Heat under) reflux OR microwave (in sealed container)		1

Question Number	Acceptable Answers	Reject	Mark
18 (a) (iv)	CH ₃ COCl / CH ₃ COO(COCH ₃) / ethanoyl chloride / ethanoic anhydride ALLOW CH ₃ COOH / ethanoic acid and H ₂ SO ₄ / sulfuric acid / HCl / hydrochloric acid	Correct answer plus AlCl ₃ Acyl chloride	1

Question Number	Acceptable Answers	Reject	Mark
18 (b) (i)	steam source and r.b / pear-shaped flask (and clove buds) OR r.b / pear-shaped flask being heated and containing water (and clove buds) (1) Condenser with water jacket, in correct position and direction of water flow (1) Collection vessel (1) -1 if apparatus does not work e.g. sealed -1 for no joints or leaky joint	Conical flask if being heated with the clove buds in	3

Question Number	Acceptable Answers	Reject	Mark
18 (b) (ii)	<p>Mix organic solvent and oil-water mixture in a separating funnel then separate (1)</p> <p>Distil / rotary evaporate (to separate clove oil from organic solvent) (1)</p> <p>Add (anhydrous)CaCl₂ / (anhydrous) MgSO₄ / (anhydrous) Na₂SO₄ / silica gel / calcium oxide to clove oil, (then filter / decant) (1)</p> <p>ALLOW name or formula of drying agent</p> <p>(Second and third marks in either order)</p> <p>OR</p> <p>Add (saturated solution) of NaCl / sodium salt (1)</p> <p>Separate in a separating funnel (1)</p> <p>Add named drying agent to clove oil, (then filter / decant) (1)</p>	(Anhydrous) CuSO ₄ NaOH, sodium carbonate, sodium hydrogencarbonate, calcium carbonate	3

Question Number	Acceptable Answers	Reject	Mark
18 (c)	<p>Choice with justification (1) e.g. 'yes it's reasonable as clove oil may be in use at harmful /toxic levels so we need to identify what that level is'</p> <p>'no as clove oil has been in use for many years in many ways so tests on animals not necessary to confirm it's safe to use at current levels' / no, as humans would have to consume large amounts</p>	<p>Yes because it's toxic</p> <p>No, because of objections to animal testing in general</p>	1

Question Number	Acceptable Answers	Reject	Mark
18 (d)*	<p>4 clear justified comparisons - 1 mark each</p> <p>ScCO₂ oil obtained seems purier (as colour closely matches that of eugenol)</p> <p>requires no further purification, (others use solvent extraction)</p> <p>greater yield per hour</p> <p>yield 15.3g per 100g of buds</p> <p>no organic solvent (because it is chlorinated) and so environmental problems / harmful / damage ozone layer</p> <p>requires high pressure so likely to be expensive / requires specialist equipment</p> <p>Steam distillation steam distillation can be done using standard lab equipment / does not require high pressures</p> <p>yield only 6.1g / 6.2g per 100g of buds</p> <p>Steam gives the least yield per hour</p> <p>Soxhlet produces greater yield of oil but has a smaller percentage of eugenol / eugenol ethanoate</p> <p>yield 16.8g per 100g of buds</p> <p>(takes longer) but does not require high pressures</p> <p>uses organic solvent (because it is chlorinated) and so environmental problems / harmful / damage ozone layer</p> <p>Oil obtained seems least pure</p> <p style="text-align: right;">(4)</p> <p>Synthetic route has several steps, each with a low yield clove buds are renewable but materials in synthesis are not / materials in synthesis likely to be obtained from oil</p> <p style="text-align: right;">(1)</p>	<p>produces pale yellow oil</p> <p>Just no organic solvent</p> <p>Only two hours / shorter time than other methods Just higher percentage yield</p> <p>Just no organic solvent</p> <p>Higher yield than soxhlet</p> <p>Cost of chemicals Yield is 35 %</p>	5

TOTAL FOR SECTION C = 20 MARKS

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