Mark Scheme (Standardisation)

Summer 2008

GCE

GCE Chemistry Nuffield (6254/01)

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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.

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 <u>meaning</u> 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.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	Any three from •Titrate with (sodium) thiosulphate to measure concentration of I_2. •Titrate with an **alkali/base** (eg sodium hydroxide) to measure concentration of H^+/acid. •Titrate with silver ions to measure I^- •Measure colour change (**colorimetry**) as iodine is coloured [colour changes not needed] •Use pH (meter) to measure H^+/acidity •Measure conductivity as (2) **ions** on RHS IGNORE any reference to quenching	IGNORE indicators unless inappropriate e.g. starch Addition of starch to give colour	Dilatometry I^- If incorrect colours given, then no mark. Benedict's solution to give colour Electrolysis Measure volume of hydrogen	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	Add sodium (hydrogen)carbonate **(1)** which neutralises/reacts with/removes the H^+ **(1)** 2nd mark awarded only if an alkali added	Ice/ice-cold water to slow the reaction max 1	Alkali/base/sodium hydroxide Cold water	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	First order **(1)** In exp 2 and exp 3 / concentrations of iodine and H^+ remain constant **(1)** propanone concentration increases by 1.5 times and the rate also increases by 1.5 times **(1)**	Could compare experiments 1 and 3		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	Zero (order) / 0 (order)	Zeroth (order)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(iii)	Rate = $k[H^+][CH_3COCH_3]$ ALLOW TE from (i) and (ii) IGNORE state symbols	Rate = $k[H^+][CH_3COCH_3][I_2]^0$ "R" or "r" for rate "K" for "rate constant"		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(iv)	H^+ and CH_3COCH_3 IGNORE state symbols	Names, [], displayed formula ALLOW TE from rate equation in (iii)		1

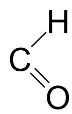
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(v)	$CH_3COCH_3 + H^+ \rightarrow CH_3C^+OHCH_3$ **(1)** "+" can appear anywhere on formula "+" sign must appear on the product for the 1st mark The (positive) hydrogen ion is attracted to the lone pair of electrons / δ^- on the oxygen atom (in the propanone). **(1)**		No TE from earlier parts	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(i)	Contains **two** double bonds /2 C=C / 1 x C=C and 1 x C=O	Triple bond	A double bond Does not contain a benzene ring Alkene Double bonds	1

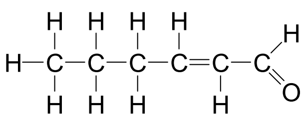
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	Does not contain an –OH group	"Not an alcohol" OR "Not an hydroxyl" OR "hydroxyl" OR "Not an alcohol nor a carboxylic acid/nor a phenol"	"Not a hydroxide" "Not a carboxylic acid" "Not a phenol"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(iii)	Contains one C=C/ a C=C bond			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(iv)	"Aldehyde or ketone" (**both needed**) OR carbonyl compound	C=O		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(v)	Aldehyde	CHO OR 		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(vi)	Has the same two groups across (on opposite sides) a C=C	May be shown in a diagram OR in (vii)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(vii)	Alkene and aldehyde groups anywhere in molecule [but must have 6 carbons, 10 hydrogens and 1 oxygen] **(1)** Trans and rest of molecule **(1)** 	$CH_3CH_2CH_2$–		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	Nickel / platinum and hydrogen **(1)** Lithium tetrahydridoaluminate((III)) **(1)** Either order	formulae Lithium aluminium hydride Ignore solvent unless water – then reject Sodium tetrahydridoborate((III)) /borohydride	Sodium and ethanol	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	(primary) alcohol	Hydroxyl OR hydroxy	OH OR hydroxide OR OH^-	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	Liquids are more disordered than solids/ solids are more ordered than liquids/ solids are less disordered than liquids / liquids are less ordered than solids	More ways of arranging energy in a liquid because of translation/rotation energy	Just "more ways of arranging energy"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	(165 + 217.1 – 166.5 =) + 215.6 OR +216 (J mol^{-1} K^{-1}) "+" sign essential	+(0).2156 kJ mol^{-1} K^{-1} OR +0.216 kJ mol^{-1} K^{-1}	215 J mol^{-1} K^{-1} 0.215 kJ mol^{-1} K^{-1}	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iii)	Yes because The products include a gas **(1)** One mole/molecule goes to two moles/molecules **(1)**	Solid goes to liquid and gas for first mark	 1 reactant goes to 2 products does not get 2nd mark	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)	$\Delta S^{\ominus}_{surroundings} = \dfrac{-\Delta H}{T}$ OR $\dfrac{-123800}{298}$ **(1)** = - 415 J mol^{-1} K^{-1} **(1)**	- 0.415 kJ mol^{-1} K^{-1} -415.4 J mol^{-1} K^{-1} final answer with no working (2) Allow "j" for "J"	Full calculator display eg -415.4362416 more than 2 dp e.g. -415.436	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	ΔS_{total} = -415 + 216 = -199 or -199.8 or -200) (J mol^{-1} K^{-1}) IGNORE 4th significant figure	-0.199 kJ mol^{-1} K^{-1} ALLOW TE from(a)(ii) and (b)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	reactants predominate / equilibrium lies well to the left OR Equilibrium completely to the left	ALLOW TE from (c)(i)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(i)	$K_p = \frac{p_{PCl_3} \times p_{Cl_2}}{p_{PCl_5}}$ **(1)** IGNORE state symbols or lack of them unless (s) or (l) Units atm **(1)**	Capital “P” Use of ( ) If expression the wrong way up allow second mark if units given as atm^{-1}	Use of [ ]	2

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>3 (d)(ii)</td><td>
<table>
<tr><th>Substance</th><th>Moles at start</th><th>Moles at equilibrium</th><th>P_{eq} /atm</th></tr>
<tr><td>PCl_5(g)</td><td>0.20 (1)</td><td></td><td>$\frac{0.15}{0.25} \times 4.32$ = 2.592</td></tr>
<tr><td>PCl_3(g)</td><td></td><td>0.05</td><td>$\frac{0.05}{0.25} \times 4.32$ = 0.864</td></tr>
<tr><td>Cl_2(g)</td><td></td><td>0.05</td><td>0.864</td></tr>
<tr><td colspan="2">Total number of moles at equilibrium</td><td>0.25</td><td></td></tr>
</table>
All three(1) All three(1)

Allow consequential marking across columns</td><td>If moles at eqm are given as 0.025 for PCl_3(g) and for Cl_2(g) then 4th column should be
3.24, 0.54 and 0.54

and gets 2 (out of 3)</td><td></td><td>3</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(iii)	(K_p = $\frac{0.864 \times 0.864}{(2.592)}$ = 0.288 (atm)	ALLOW TE from 3di and from 3dii Common wrong values above gives 0.090 ALLOW 0.29	0.3 0.28	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(iv)	**A** No change because K_p depends only on temperature / number of moles would change in same proportion **(1)** **B** Increase because reaction is endothermic **(1)** OR entropy arguments	If both changes correct but no explanations then **1 (out of 2)**		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	**Step 1** <u>Reagent</u> Fuming sulphuric acid / sulphur trioxide/sulphur(VI) oxide/oleum **(1)** <u>Conditions</u> Reflux / heat **(1)** Only allow heat for this mark if the reagent is reasonable (e.g. conc sulphuric acid) **Step 2** <u>Reagent</u> Sodium hydroxide **(1)**	SO_3/$H_2S_2O_7$ If just stated temperature must be above 75 °C sodium carbonate/ sodium hydrogencarbonate/ sodium	(Concentrated) sulphuric acid/ H_2SO_4 sodium chloride	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	**Step 1** (electrophilic) substitution **(1)** **Step 2** neutralisation or acid-base **(1)**	sulphonation	Nucleophilic substitution	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	Friedel-Craft(s) Accept phonetic spelling	Alkylation		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	<u>Reagent</u> $C_{12}H_{25}Cl$ OR $C_{12}H_{25}Br$ **(1)** <u>Catalyst</u> $AlCl_3$ **(1)**	 (1-)chlorododecane $C_{12}H_{25}I$ Al_2Cl_6 Aluminium chloride	 $AlCl_4$ $AlCl_4^-$	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)	(Soapless) detergent OR a specific example	Surfactants	Dyes Drugs Antiseptics	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(i)	$K_a = \frac{[H^+] \times [HCO_3^-]}{[CO_2]}$ **(1)** mol dm^{-3} **(1)** If H_2O is included as denominator then allow only the 2nd mark if no units suggested			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(ii)	$pK_a = -\log K_a$ / $-\lg K_a$ / $-\log_{10} K_a$	$K_a = 10^{-pKa}$		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)	A solution which does not change its pH value (significantly) **(1)** When some/small amount of acid or alkali is added **(1)**	May be shown using an equation		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)	Acting as a base because it is accepting a proton (to form H_2CO_3/CO_2 + H_2O)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d)(i)	Before race $7.4 = 6.5 - \log \frac{[acid]}{[base]}$ $\log \frac{[acid]}{[base]} = -0.9$ **(1)** $\frac{[acid]}{[base]} = 0.126$ **(1)**	0.13	0.12	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d)(ii)	Before race $[CO_2] = 0.126 \times 0.0224 = 2.82 \times 10^{-3}$ OR $2.52 \times 10^{-2} - 2.24 \times 10^{-2} = 2.8 \times 10^{-3}$			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d)(iii)	Hypothesis I would result in an increase in $[CO_2]$ / $[HCO_3^-]$ / $[CO_2 + HCO_3^-]$ OR Hypothesis II would produce greater acidity without additional $[CO_2]$ / $[HCO_3^-]$ / $[CO_2 + HCO_3^-]$ **(1)** The table shows a fall in $[CO_2]$ / $[HCO_3^-]$ / $[CO_2 + HCO_3^-]$ and therefore Hypothesis II must be favoured. **(1)**			2