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Mark Scheme (Results)

June 2011

GCE Chemistry (6CH05) Paper 01
General Principles of Chemistry II

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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. Questions labelled with an **asterix (*)** are ones where the quality of your written communication will be assessed.

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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	Mark
1 (a)	D	**1**

Question Number	Correct Answer	Mark
1 (b)	B	**1**

Question Number	Correct Answer	Mark
1 (c)	A	**1**

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

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

Question Number	Correct Answer	Mark
4 (a)	B	**1**

Question Number	Correct Answer	Mark
4 (b)	C	**1**

Question Number	Correct Answer	Mark
4 (c)	A	**1**

Question Number	Correct Answer	Mark
5 (a)	B	**1**

Question Number	Correct Answer	Mark
5 (b)	D	**1**

Question Number	Correct Answer	Mark
5 (c)	C	**1**

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

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

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

Question Number	Correct Answer	Mark
9 (a)	A	**1**

Question Number	Correct Answer	Mark
9 (b)	C	**1**

Question Number	Correct Answer	Mark
9 (c)	D	**1**

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

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

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

TOTAL FOR SECTION A = 20 MARKS

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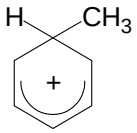
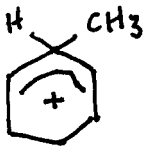
Section B

Question Number	Acceptable Answers	Reject	Mark
13 (a)(i)	CH_3Cl / CH_3Br / CH_3I Ignore name and state symbols Allow displayed formula	Name alone	**1**

Question Number	Acceptable Answers	Reject	Mark
13 (a)(ii)	$CH_3Cl + AlCl_3 \rightarrow CH_3^+ + AlCl_4^-$ Allow $CH_3^{\delta+}$ $AlCl_4^{\delta-}$ and other halogens Ignore state symbols and curly arrows	$CH_3^{\delta+}$-$AlCl_3^{\delta-}$ + Cl^-	**1**

Question Number	Acceptable Answers	Reject	Mark
13 (a)(iii)	 Ignore curly arrows and use of wedges/dashes Ignore attempts to complete mechanism if intermediate is correct Must show reasonable delocalisation over at least 3 carbon atoms Allow positive charge anywhere inside benzene ring Allow delocalization shown as dashed line e.g  Allow correct Kekulé structure	Complete circle of delocalization 'Upside down' delocalization e.g. 	**1**

Question Number	Acceptable Answers	Reject	Mark
13 (b)(i)	(Methyl group) donates/increases electron density to the ring/feeds electrons into ring Allow the methyl group is electron releasing	Donates **lone** pair of electrons Ring becomes more electronegative Just 'inductive effect'	**1**

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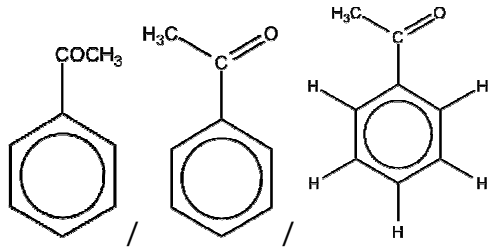
Question Number	Acceptable Answers	Reject	Mark
13 (b)(ii)	(Methylbenzene) is more susceptible to electrophilic attack/attack by **positive** species/makes it a stronger nucleophile Ignore comments about ring stability Allow methyl group stabilizes carbocation		**1**

Question Number	Acceptable Answers	Reject	Mark
13 (c)(i)	 $C_6H_5COCH_3$ / / / Allow displayed or skeletal formulae or Kekulé		**1**

Question Number	Acceptable Answers	Reject	Mark
13 (c)(ii)	**Any 2 from 4** Lower energy input (to heat reaction)/less heat losses/more efficient heating **(1)** Electrical energy can be obtained from renewable resources whereas gas is non renewable **(1)** Easier separation of catalyst/(easier to) re-use catalyst **(1)** Involves less chlorine/chlorine compounds **(1)** Ignore any comments regarding carbon dioxide level/global warming	Faster reaction because using a catalyst Just 'uses less fuel' Just uses less toxic/harmful chemicals	**2**

Question Number	Acceptable Answers	Reject	Mark
13 (d)	Fuming sulfuric acid / oleum / sulfur trioxide (dissolved) in concentrated sulfuric acid Allow fuming H_2SO_4 /$H_2S_2O_7$ / SO_3 (dissolved) in concentrated H_2SO_4	Just sulfuric acid or sulfur trioxide	**1**

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Question Number	Acceptable Answers	Reject	Mark
14 (a)(i)	Conc. Nitric acid **(1)** Conc. Sulfuric acid **(1)** Allow correct formulae Ignore state symbols Sulfuric acid and nitric acid with no mention of concentrated scores (1)		**2**

Question Number	Acceptable Answers	Reject	Mark
14 (a)(ii)	Pear shaped/round bottomed flask & heat source **(1)** Allow vertical arrow with or without the word heat Allow water bath as a heat source Liebig condenser, shown vertically **(1)** (Water) flow shown correctly into a jacket **(1)** Ignore thermometers unless stoppered Penalise (one for each): Stopper/sealed Gaps between flask and condenser Condenser inner tube extends into liquid in flask	Conical flask in diagram or label	**3**

Question Number	Acceptable Answers	Reject	Mark
14 (a)(iii)	Heat Speed up reaction / to overcome the activation energy / provide energy to break bonds / because activation energy for the reaction is high **(1)** Under reflux Prevent escape of reactants / products Or As they may be flammable / harmful / volatile **(1)**	Just to provide energy for the reaction to start Just to increase the yield/make reaction go to completion	**2**

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Question Number	Acceptable Answers	Reject	Mark
14 (a)(iv)	$HOCH_2CH_2N(C_2H_5)_2$ Allow $OHCH_2CH_2N(C_2H_5)_2$ Allow displayed or skeletal formulae		**1**

Question Number	Acceptable Answers	Reject	Mark
14 (a)(v)	Reduction **(1)** Allow redox Tin / iron / zinc **and** (conc./dilute) hydrochloric acid **(1)** Accept correct names or formulae for both alternatives Ignore references to tin as a catalyst Ignore conditions Allow $NaBH_4$ in alkali (Pd catalyst)	Addition of NaOH unless clearly after the reduction Hydrogen gas and nickel (catalyst) $LiAlH_4$	**2**

Question Number	Acceptable Answers	Reject	Mark
14 (b)(i)	Moles of 2-hydroxy benzoic acid = 9.4/138 **(1)** (= 0.0681) So theoretical yield of aspirin = 0.0681 x 180 **(1)** = 12.26 g % yield = 100 x 7.77/12.26 = 63.4% **(1)** Or Moles of 2-hydroxy benzoic acid = 9.4/138 **(1)** (= 0.0681) Moles of aspirin = 7.77/180 **(1)** (=0.0432) % yield = 100 x 0.0432/0.0681 = 63.4/63% **(1)** Correct answer with no working 3 marks Allow 1 max. if *M*r values are transposed 108%	100 x 7.77/9.40 = 82.7%	**3**

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Question Number	Acceptable Answers	Reject	Mark
14 *(b)(ii)	Dissolve/add to impure solid in min. volume / amount **(1)** of hot solvent / water **(1)** (Filter whilst hot) Allow to cool **and** filter off product / (re)crystallize **and** filter off product **(1)** Wash with cold / small amount of solvent / water (then dry) **(1)**	Just 'small/little amount of water' Named solvents other than water – penalise once	**4**

Question Number	Acceptable Answers	Reject	Mark
14 (b)(iii)	It reduces yield as some product remains in solution Allow stated and explained errors due to transfer e.g. left on filter paper	Just 'transfer errors'	**1**

Question Number	Acceptable Answers	Reject	Mark
14 (c)(i)	CH_3COCl / $(CH_3CO)_2O$ / ethanoyl chloride / ethanoic anhydride If both name and formula are given then both must be correct Allow acetyl chloride / acetic anhydride Ignore any additional information Allow displayed formulae	Ethanoic acid	**1**

Question Number	Acceptable Answers	Reject	Mark
14 (c)(ii)	(Lessen) risk of overdose / as paracetamol is toxic in larger doses/ as paracetamol is harmful in larger doses / reduce risk of taking medication over a longer time period than necessary / reduce risk of addiction		**1**

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Question Number	Acceptable Answers	Reject	Mark
14 (c)(iii)	Net forces between paracetamol and water are less than the forces between water and water and / or paracetamol and paracetamol Allow benzene / ring doesn't interact with water Allow benzene ring is hydrophobic / non polar / only forms London forces / can't form hydrogen bonds	Just paracetamol / benzene ring is large / steric hindrance	**1**

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Question Number	Acceptable Answers	Reject	Mark
15 (a)	Either Anode $H_2 - 2e^{(-)} \rightarrow 2H^+$ **(1)** Cathode $O_2 + 4H^+ + 4e^{(-)} \rightarrow 2H_2O$ **(1)** Or Anode $H_2 + 2OH^- - 2e^{(-)} \rightarrow 2H_2O$ **(1)** Cathode $O_2 + 2H_2O + 4e^{(-)} \rightarrow 4OH^-$ **(1)** Electrons can be on either side of the equation Allow multiples Allow equilibria signs Ignore state symbols		**2**

Question Number	Acceptable Answers	Reject	Mark
15 (b)	One advantage e.g. quieter, more efficient (energy transfer), no NO_x formed Ignore references to carbon dioxide and / or water as only product	Just easier to control	**1**

Question Number	Acceptable Answers	Reject	Mark
15 (c)	Ethanol can be obtained from biomass / plants / fermentation / ethanol is a bio fuel **(1)** hydrogen from (electrolysis of) water using a non-fossil source of energy **(1)** these are renewable / fossil fuels are a finite resource **(1)** Allow for third mark so less burning/use of fossil fuels hence lower carbon emissions / less impact on greenhouse effect		**3**

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Question Number	Acceptable Answers	Reject	Mark
16 (a)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 (4s^0)$ **(1)** Accept $[Ar]3d^5(4s^0)$ (Ion) has an incompletely filled (3)d-orbital / sub-shell / unpaired d electron **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
***16 (b)**	Gases adsorb onto / bind to catalyst (surface) **(1)** Allow gases are absorbed onto surface Then react **and** desorb / leave **(1)** Reaction could be faster because Any two • These processes lower the activation energy (by providing an alternative route so a greater proportion of molecules react) • Bonds in reactant(s) are weakened • Reactants may be positioned in more favourable orientations • Reactants can migrate towards each other on surface • Increases likelihood of molecules coming into contact / colliding • Adsorption onto surface means more reactant molecules in a given space	Just 'bonds in reactants are broken'	**4**

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Question Number	Acceptable Answers	Reject	Mark
16 (c)	E_{cell} for reaction is (+) 0.84 (V) (so will work) / E_{cell} for item 44 is more positive than for item 19 / illustrate using anti-clockwise rule **(1)** $2Fe + O_2 + 2H_2O \rightarrow 2Fe^{2+} + 4OH^-$ or $2Fe + O_2 + 2H_2O \rightarrow 2Fe(OH)_2$ **(1)** E_{cell} for reaction is (+)0.96 (V) (so will work) / E_{cell} for item 44 is more positive than for item 17 / illustrate using anti-clockwise rule **(1)** $4Fe(OH)_2 + O_2 + 2H_2O \rightarrow 4Fe(OH)_3$ **(1)**	Just 'because of the anti-clockwise rule'	**4**

Question Number	Acceptable Answers	Reject	Mark
16 (d)	Lone pair(s) (from nitrogen(s)) **(1)** Forms dative / dative covalent / coordinate bond (with Fe^{2+}) **(1)**		**2**

TOTAL FOR SECTION B = 48 MARKS

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Section C

Question Number	Acceptable Answers	Reject	Mark
17 (a)(i)	$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ **(1)** $CH_3CH_2OH + H_2O \rightarrow CH_3COOH + 4H^+ + 4e^-$ **(1)** Allow multiples Ignore state symbols		**2**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(ii)	$3CH_3CH_2OH + 2\ Cr_2O_7^{2-} + 16H^+ \rightarrow 3CH_3COOH + 4Cr^{3+} + 11H_2O$ Allow hydrogen ions and water molecules not cancelled e.g. $3CH_3CH_2OH + 2\ Cr_2O_7^{2-} + 28H^+ \rightarrow 3CH_3COOH + 4Cr^{3+} + 11H_2O + 12H^+$ $3CH_3CH_2OH + 2\ Cr_2O_7^{2-} + 16H^+ + 3H_2O \rightarrow 3CH_3COOH + 4Cr^{3+} + 14H_2O$ $3CH_3CH_2OH + 2\ Cr_2O_7^{2-} + 28H^+ + 3H_2O \rightarrow 3CH_3COOH + 4Cr^{3+} + 14H_2O + 12H^+$	Equations with electrons	**1**

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Question Number	Acceptable Answers	Reject	Mark
***17 (a)(iii)**	Moles of thiosulfate = 34.40/1000 x 0.025 = 8.6 x 10^{-4} (mol) **(1)** So moles I_2 = 4.3 x 10^{-4} (mol) **(1)** So moles of dichromate unreacted = 4.3 x 10^{-4} / 3 = 1.433 x 10^{-4} (mol) **(1)** So moles of dichromate reacted with ethanol = 8 x 10^{-4} – 1.43 x 10^{-4} = 6.567 x 10^{-4} (mol) **(1)** So moles of ethanol = 6.567 x 10^{-4} x 3/2 mol = 9.85 x 10^{-4} (mol) **(1)** Concentration = 9.85 x 10^{-4} /0.005 = 0.197 (mol dm^{-3}) **(1)** Correct answer (0.197) with no working 6 marks Allow 4 max. for missing subtraction in step 4 and gaining answer of 0.043(0)		**6**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(iv)	0.197 x 10 = 1.97 (mol dm^{-3}) Allow answer to (a) (iii) x 10		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(v)	To prevent other (non volatile) substances (in the drink) from reacting with the dichromate ions		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(vi)	because it allows the ethanol to evaporate (allowing it to mix with the dichromate) **(1)** make sure all ethanol reacts **(1)** Concentration / results would have been lower than the actual value **(1)**		**3**

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Question Number	Acceptable Answers	Reject	Mark
17 (a)(vii)	No, as only one sample titrated so no evidence that results are repeatable / no, as not all the ethanol has evaporated/no, as the dichromate may have reacted with something else/ no, as not all the ethanol has reacted Allow only 1 titration carried out		**1**

Question Number	Acceptable Answers	Reject	Mark
***17 (b)(i)**	Early breathalysers: (the extent to which) dichromate turns **green (1)** Fuel cells: (more alcohol means larger) current / quantity of electricity **(1)** Infrared breathalysers: (more alcohol means greater) absorbance **(1)** Ignore reference to specific bonds provided they are present in ethanol	Just colour change Just 'potential difference measured' Just 'voltage measured' Just 'gives a peak'	**3**

Question Number	Acceptable Answers	Reject	Mark
17 (b)(ii)	Water (in the breath) also has an OH bond Allow other named molecules on the breath provided they have an OH bond		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (b)(iii)	Additional evidence is more reliable Or Police often use IR as well as fuel cell breath test to provide sufficient evidence to prosecute (without need for blood test) Or Fuel cell breathalysers are portable and determine whether or not to check with IR at the police station	Answers only related to accuracy	**1**

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Question Number	Acceptable Answers	Reject	Mark
17 (b)(iv)	Advantage It could check if you are below the legal limit / safe to drive **(1)** Disadvantage It may not be sensitive enough to give an accurate reading / may give a value that does not closely match police value OR It encourages people to drink and drive **(1)**		**2**

TOTAL FOR SECTION C = 22 MARKS

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