

Mark Scheme
(Results)

Summer 2012

GCE Chemistry (6CH02) Paper 01
Application of Core Principles of
Chemistry

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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.

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.

Section A (multiple choice)

Question Number	Correct Answer	Reject	Mark
1 (a)	B		1
(b)	C		1
(c)	D		1

Question Number	Correct Answer	Reject	Mark
2 (a)	C		1
(b)	D		1

Question Number	Correct Answer	Reject	Mark
3	D		1

Question Number	Correct Answer	Reject	Mark
4	A		1

Question Number	Correct Answer	Reject	Mark
5	A		1

Question Number	Correct Answer	Reject	Mark
6	D		1

Question Number	Correct Answer	Reject	Mark
7	B		1

Question Number	Correct Answer	Reject	Mark
8	C		1

Question Number	Correct Answer	Reject	Mark
9	D		1

Question Number	Correct Answer	Reject	Mark
10	A		1

Question Number	Correct Answer	Reject	Mark
11	C		1

Question Number	Correct Answer	Reject	Mark
12	B		1

Question Number	Correct Answer	Reject	Mark
13 (a)	C		1
(b)	B		1

Question Number	Correct Answer	Reject	Mark
14	A		1

Question Number	Correct Answer	Reject	Mark
15	B		1

Question Number	Correct Answer	Reject	Mark
16	A		1

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
17 (a) (i)	<p>More O₃ is formed/equilibrium shifts to the right (1)</p> <p>Because (increase in temperature) favours endothermic reaction ALLOW (Forward) reaction is endothermic</p> <p>ALLOW ΔH is positive for endothermic (1)</p> <p>IGNORE references to rate and pressure change</p>	equilibrium shifts to the left (scores zero overall)	2

Question Number	Acceptable Answers	Reject	Mark
17 (a) (ii)	<p>The mixture becomes darker ALLOW: more blue/bluer (1)</p> <p>(Increase in pressure) favours side with fewer moles/molecules (of gas) (so equilibrium shifts to the right) (1)</p> <p>IGNORE references to rate</p> <p>Marks are stand alone</p>	<p>Just 'more ozone'</p> <p>Blue gas formed</p> <p>Mixture becomes blue</p> <p>Atoms/particles</p>	2

Question Number	Acceptable Answers	Reject	Mark
17 (a) (iii)	<p>The equilibrium is dynamic OR Forward & reverse reactions still occurring OR O₃ continues to be formed from O₂ at the same rate as O₃ decomposes OR O₃ continues to be formed from O₂ with no nett change in composition</p>		1

Question Number	Acceptable Answers	Reject	Mark
17(b)(i)	<p>In (b) Any units given must be correct. Penalise once</p> <p>IGNORE SF except 1 SF. Penalise once</p> <p>TE at each step through calculation</p> <p>Amount of thiosulfate $= 0.0155 \times 25.50 \times 10^{-3}$ $= 3.9525 \times 10^{-4} \text{ (mol)}$ Or correct answer with no working</p>		1

Question Number	Acceptable Answers	Reject	Mark
17(b)(ii)	<p>1 mol I₂ reacts with 2 mol S₂O₃²⁻</p> <p>ALLOW 'using equation 2'</p> <p>\therefore Amount of iodine = answer in (b)(i) / 2 (1)</p> <p>$= 3.9525 \times 10^{-4} / 2 = 1.97625 \times 10^{-4} \text{ (mol)}$ (1)</p> <p>Correct answer with no working (2)</p> <p>If ratio reversed, TE only if ratio is stated</p>		2

Question Number	Acceptable Answers	Reject	Mark
17(b)(iii)	<p>Amount of iodine = Amount of ozone</p> <p>= answer in (b)(ii)</p> <p>$= 1.97625 \times 10^{-4} \text{ (mol)}$</p>		1

Question Number	Acceptable Answers	Reject	Mark
17(b)(iv)	<p>Volume of ozone = answer in (b)(iii) x 0.024</p> <p>$= 1.97625 \times 10^{-4} \times 0.024$</p> <p>$= 4.743 \times 10^{-6} \text{ (m}^3 \text{ in } 100 \text{ m}^3\text{)}$</p>		1

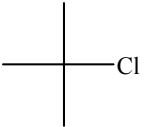
Question Number	Acceptable Answers	Reject	Mark
17(b)(v)	<p>Volume of ozone in ppm</p> <p>= answer in (b)(iv) x 10⁶ ÷ 100</p> <p>$= 4.743 \times 10^{-6} \times 10^4$</p> <p>$= 4.743 \times 10^{-2} = 0.04743 \text{ (ppm)}$</p>		1

Question Number	Acceptable Answers	Reject	Mark
17 (b)(vi)	<p><u>(Increase reliability)</u> because a mean (average) value can be used/ anomalous results (ALLOW outliers) may be identified</p> <p>ALLOW the titration can be repeated (1)</p> <p><u>(Decrease accuracy)</u> because smaller titration volume/volume of thiosulfate ALLOW volume of (acidified) KI ALLOW 'amount' for 'volume' (1)</p> <p>so percentage error/uncertainty will increase (1)</p> <p>The % error mark is NOT stand alone but 'smaller volume increases percentage error' scores final mark</p>	Experiment can be repeated More results	3

Question Number	Acceptable Answers	Reject	Mark
17(c)	<p>Oxygen in $O_3 = 0$ and $O_2 = 0$ (1) in $H_2O = -2 / 2-$ (1)</p> <p>Ozone acts as an oxidizing agent. ALLOW 'is reduced' / oxidizes I^- (1)</p> <p>Third mark is stand alone; No TE on incorrect oxidation numbers</p>		3

Question Number	Acceptable Answers	Reject	Mark
17 (d)	(Residual) ozone is (quickly) converted into (odourless) oxygen OR chlorine has a persistent/unpleasant odour or taste OR Chlorine forms HCl/ hydrochloric acid (in drinking water)	(Oxygen) and water Ozone is odourless/cheap /more available Chlorine forms free radicals/ hazardous compounds/ reacts with hydrogen/ damages ozone layer	1

Question Number	Acceptable Answers	Reject	Mark
18 (a)(i)	<p>X = 2-chloro-2-methylpropane ALLOW X = 2,2-chloromethylpropane X = 2-methyl-2-chloropropane X = 2,2-methylchloropropane X = 2-chloromethylpropane (1)</p> <p>Z = 2-methylpropan-2-ol (1) ALLOW methylpropan-2-ol ALLOW propane for propan</p> <p>IGNORE omission of (or extra) commas and hyphens IGNORE spaces</p>	<p>2-methylchloropropane</p> <p>Hydroxy for -ol</p>	2

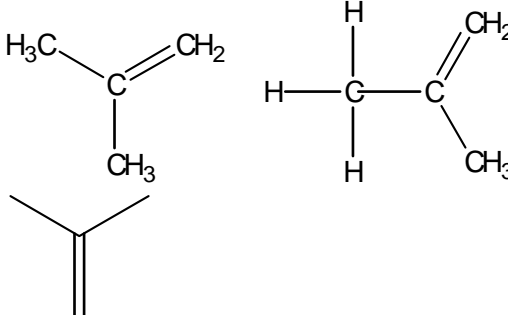
Question Number	Acceptable Answers	Reject	Mark
18 (a)(ii)	 <p>ALLOW any angles</p>	Any other type of structure	1

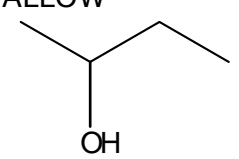
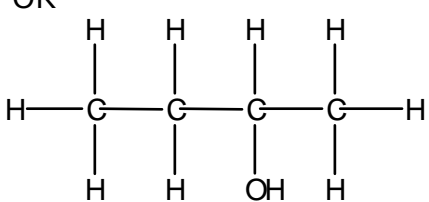
Question Number	Acceptable Answers	Reject	Mark
18 (a)(iii)	Tertiary ALLOW recognisable abbreviations: 3 ^y /3 ^o		1

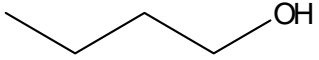
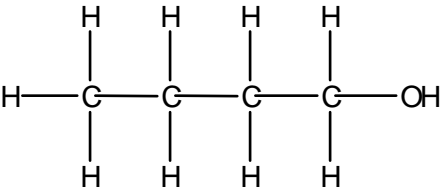
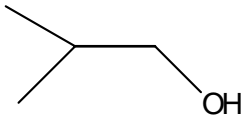
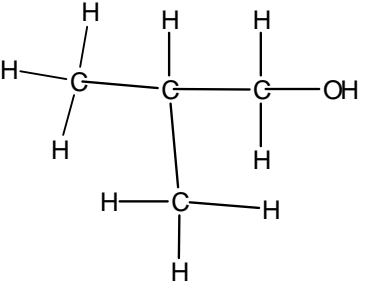
Question Number	Acceptable Answers	Reject	Mark
18 (b)(i)	<p>Nucleophilic (1)</p> <p>Substitution (1)</p> <p>S_N1 scores 1/2</p>	S _N 2	2

Question Number	Acceptable Answers	Reject	Mark
18 (b)(ii)	<p>Movement (ALLOW Transfer/donation)/ start and finish positions of an electron pair ALLOW two electrons for pair</p> <p>IGNORE bonded/unbonded for electrons</p> <p>IGNORE heterolytic bond breaking and bond formation</p>	electrons	1

Question Number	Acceptable Answers	Reject	Mark
18 (b)(iii)	<p>These marks are stand alone</p> <p>Trigonal (ALLOW triangular) planar/ planar with bond angles of 120° (1)</p> <p>3 bond pairs (no lone pairs) of electrons (1)</p> <p>ALLOW 3 pairs of electrons around the central atom/ carbon</p> <p>Arranged at minimum repulsion (1)</p> <p>ALLOW maximum separation / distance apart</p> <p>IGNORE references to the positive charge</p>	<p>Bonds or 'areas of electron density' for pairs Just '3 pairs of electrons'</p> <p>Just 'repel'</p> <p>Repel as much as possible</p>	3

Question Number	Acceptable Answers	Reject	Mark
18 (b)(iv)	<p>(Type of reaction:) elimination ALLOW dehydrohalogenation (1) IGNORE nucleophilic</p> <p>Product: 2-methylpropene ALLOW methylpropene 2-methylprop-1-ene Methylprop-1-ene</p> <p>any correct formula e.g. $(\text{CH}_3)_2\text{CCH}_2$ ALLOW $\text{CH}_3\text{C}(\text{CH}_3)\text{CH}_2$</p>  <p>(1)</p> <p>If a displayed formula or part displayed formula is used, all the atoms must be shown.</p>	2-methylprop-2-ene methylprop-2-ene	2

Question Number	Acceptable Answers	Reject	Mark
18 (c)(i)	<p>If a displayed formula or part displayed formula is used, all the atoms must be shown.</p> <p>If a carbon is <i>clearly</i> shown bonded to the H in OH, penalise once in (c)</p> <p>$\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$ ALLOW</p>  <p>OR</p> 		1

Question Number	Acceptable Answers	Reject	Mark
<p>18 (c) (ii)</p>	<p>$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ (1)</p> <p>ALLOW</p>  <p>or</p>  <p>$(\text{CH}_3)_2\text{CHCH}_2\text{OH}$ (1)</p> <p>ALLOW</p>  <p>OR</p>  <p>If 2 correct carboxylic acids are shown, 1 out of 2</p>	Aldehydes	2

Question Number	Acceptable Answers	Reject	Mark
19 (a) (i)	$2\text{KNO}_3 \rightarrow 2\text{KNO}_2 + \text{O}_2$ Or multiples or equation divided by 2 ALLOW O_2 on LHS if balanced by additional O_2 on RHS IGNORE state symbols even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
19 (a) (ii)	$2\text{Ca}(\text{NO}_3)_2 \rightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$ Or multiples or equation divided by 2 ALLOW O_2 on LHS if balanced by additional O_2 on RHS IGNORE state symbols even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
19 (b)	Brown gas (ALLOW fumes or vapour) evolved (1) IGNORE Effervescence/bubbles EITHER (White) solid melts (and then solidifies/freezes) OR (Colourless) liquid forms (1) IGNORE white solid formed		2

Question Number	Acceptable Answers	Reject	Mark
19 (c)	<p>Penalise any omission of reference to ion in MP 1 only but calcium ions or Ca^{2+} and potassium ions or K^+ are equivalent</p> <p><u>Marking Point 1</u> Calcium ions have greater positive charge (than potassium ions) OR Calcium ions 2+ but potassium ions 1+ OR Ca^{2+} but K^+ OR calcium ions are smaller (than potassium ions) OR calcium ions have greater charge density (1)</p> <p><u>Marking Point 2</u> \therefore Calcium (ions) more polarising or cause greater distortion (1)</p> <p><u>Marking Point 3</u> Of... nitrate (ion) OR anion OR N—O / N=O(bond) OR nitrate electron cloud (1)</p> <p>Reverse argument for K^+ gains full marks</p>		3

TOTAL FOR SECTION B = 40 MARKS

Section C

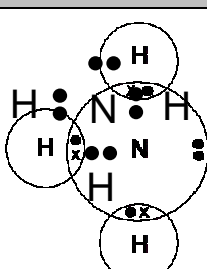
Question Number	Acceptable Answers	Reject	Mark
20 (a)(i)	(A greenhouse gas) traps/absorbs/ reflects IR (radiation) / heat (1) (re-radiating) from the earth (1) ALLOW Back to the earth	Absorbs UV (heat) from the sun From the earth's atmosphere	2

Question Number	Acceptable Answers	Reject	Mark
20 (a)(ii)	(water is a greenhouse gas) because it absorbs infrared (IR) radiation (1) The polarity of the water molecule changes when its bonds vibrate ALLOW Water is a polar molecule/has polar bonds (1)	Reflects (for absorbs) Heat (for IR) Traps IR/heat from the earth	2

Question Number	Acceptable Answers	Reject	Mark
20 (a)(iii)	$\text{CH}_4 + 2\text{H}_2\text{O} \rightarrow \text{CO}_2 + 4\text{H}_2$ ALLOW $\text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3\text{H}_2$ Species (1) balance (1) No TE on incorrect species	$\text{CH}_4 + 2\text{H}_2\text{O} \rightarrow$ $\text{CO}_2 + 8\text{H}$ $\text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO}$ $+ 6\text{H}$	2

Question Number	Acceptable Answers	Reject	Mark
20 (a)(iv)	Hydrogen is obtained from the water (as well as from the methane) OR Easier to capture the CO_2 in a chemical plant than in a moving vehicle ALLOW Higher yield of/more hydrogen		1

Question Number	Acceptable Answers	Reject	Mark
20 (a)(v)	(High cost of) energy needed (to generate the pressure) OR (High cost of) construction/ maintenance of the equipment OR (High cost of) the equipment required to withstand / contain the high pressure	High pressure is expensive	1

Question Number	Acceptable Answers	Reject	Mark
20 (b)(i)	<p style="text-align: center;">ALLOW</p>  <p>Accept dots and/or crosses for electrons, provided there are 3 bond pairs plus 2 electrons with or without lines for the bonds With or without circles</p>		1

Question Number	Acceptable Answers	Reject	Mark
20 (b)(ii)	<p>Comment Any incorrect statement cancels a correct one. The order of the marking points is not important.</p> <p>Marking Point 1 Ammonia has hydrogen bonds (as well as London forces) (1) IGNORE permanent dipole-dipole forces here</p> <p>Marking Point 2 Methane (only) has London / dispersion forces (1) ALLOW van der Waals forces</p> <p>Marking Point 3 (So) Intermolecular forces (stated or implied) in ammonia are (much) stronger than those in methane (1)</p> <p>Marking Point 4 (Ammonia has hydrogen bonds) because nitrogen is very electronegative (1) (and has a lone pair)</p> <p>OR London forces are similar in both methane and ammonia (because they have the same number of electrons) (1)</p> <p>OR So more energy is needed to separate ammonia molecules (than methane molecules)</p>		4

Question Number	Acceptable Answers	Reject	Mark
20 (c)(i)	$4\text{NH}_3 + 3\text{O}_2 \rightarrow 2\text{N}_2 + 6\text{H}_2\text{O}$ Species (1) balance (1) ALLOW Equation forming nitrogen monoxide $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$ Species (1) balance (1)	$4\text{NH}_3 + 3\text{O}_2 \rightarrow 4\text{N} + 6\text{H}_2\text{O}$	2

	No TE on incorrect species		
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Question Number	Acceptable Answers	Reject	Mark
20 (c)(ii)	Any two Energy density / energy per unit volume of the fuels ALLOW miles per gallon or equivalent (1) Cost / Ease of Production (1) Storage (1) Transport (1) Liquefaction (1) Ease of ignition (1) Corrosiveness (1) IGNORE references to Environment Renewability Safety Boiling temperatures Atom economy		2

Question Number	Acceptable Answers	Reject	Mark
20 (c)(iii)	Leaks would be easy to detect IGNORE reference to spillage		1

Question Number	Acceptable Answers	Reject	Mark
20 (c)(iv)	Ammonia is difficult to ignite/does not burn/combust easily	Ammonia is unreactive	1

Question Number	Acceptable Answers	Reject	Mark
20 (c)(v)	No because hydrogen is obtained from fossil fuels (and ammonia from hydrogen) OR Yes because hydrogen can be obtained by electrolysis of water using renewable energy sources		1

TOTAL FOR SECTION C = 20 MARKS

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