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Mark Scheme (Results)

June 2014

GCE Chemistry 6CH02/01

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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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

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	B		1

Question Number	Correct Answer	Reject	Mark
2	B		1

Question Number	Correct Answer	Reject	Mark
3	C		1

Question Number	Correct Answer	Reject	Mark
4	D		1

Question Number	Correct Answer	Reject	Mark
5	D		1

Question Number	Correct Answer	Reject	Mark
6	C		1

Question Number	Correct Answer	Reject	Mark
7	A		1

Question Number	Correct Answer	Reject	Mark
8	A		1

Question Number	Correct Answer	Reject	Mark
9	D		1

Question Number	Correct Answer	Reject	Mark
10	B		1

Question Number	Correct Answer	Reject	Mark
11	A		1

Question Number	Correct Answer	Reject	Mark
12	A		1

Question Number	Correct Answer	Reject	Mark
13	D		1

Question Number	Correct Answer	Reject	Mark
14 (a)	A		1

Question Number	Correct Answer	Reject	Mark
14 (b)	B		1

Question Number	Correct Answer	Reject	Mark
15	B		1

Question Number	Correct Answer	Reject	Mark
16	B		1

Question Number	Correct Answer	Reject	Mark
17	C		1

Question Number	Correct Answer	Reject	Mark
18	A		1

Question Number	Correct Answer	Reject	Mark
19	C		1

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
	In (a) any units given must be correct. **Penalise incorrect units once only.** **Ignore SF except 1 SF in (i), (iii) and (iv). Penalise once only**		
20 (a)(i)	<table><tr><td>Volume Added/cm^3</td><td>25(.00)</td><td>24.6(0)</td><td>24.5(0)</td></tr></table> 24.55 (cm^3) Allow 24.6 (cm^3)	 24.70 24.60	1

Question Number	Acceptable Answers	Reject	Mark
20 (a)(ii)	$NaOH + HCl \rightarrow NaCl + H_2O$ Ignore state symbols even if incorrect		1

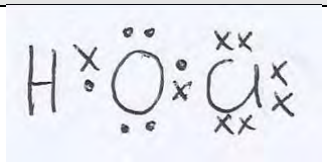
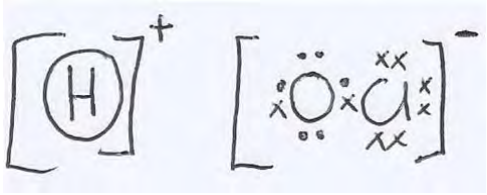
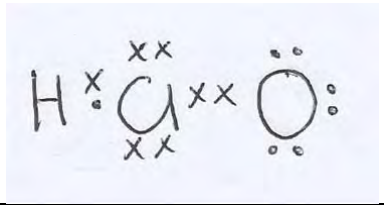
Question Number	Acceptable Answers	Reject	Mark
20 (a)(iii)	Number of moles of NaOH $= (\frac{24.55}{1000} \times 2.5) = 6.1375 \times 10^{-2} = 0.061375$(mol) OR $6.14 \times 10^{-2} = 0.0614$ OR $6.1 \times 10^{-2} = 0.061$ Allow TE from 20(a)(i)	0.0613 0.06	1

Question Number	Acceptable Answers	Reject	Mark
20 (a)(iv)	6.1375×10^{-2} /0.061375/ 6.14×10^{-2} / 0.0614/0.061(mol) Allow TE = answer to (a)(iii)		1

Question Number	Acceptable Answers	Reject	Mark
20 (a)(v)	Multiply by 4 and by 36.5 **(1)** Using 6.1375 x 10^{-2} gives 8.96075 = 8.96 (g) OR Using 6.14 x 10^{-2} gives 8.9644 = 8.96(g) OR Using 6.1 x 10^{-2} gives 8.906 = 8.91(g) Answer to **3 SF** **(1)** Correct answer without working score (2) Allow TE from (a)(iv) ALLOW one mark for correct answer to 3SF where the multiplication by 4 has been omitted, e.g. (6.1375 x 10^{-2} x 36.5 = 2.2401875 =) 2.24(g) **(1)**		2

Question Number	Acceptable Answers	Reject	Mark
20 (a)(vi)	The statement is valid as 8.96 ~9/very close Allow appropriate comment from answer to (a)(v) e.g 2.24 is not valid because it is too far away from 9g.	Just 'not valid / valid'	1

Question Number	Acceptable Answers	Reject	Mark
20 a(vii)	(Too) corrosive Damages eyes/burns (skin)/caustic Ignore Dangerous/Strong/Too concentrated	Just 'Harmful/Irritant/Toxic/Hazardous' Acid	1

Question Number	Acceptable Answers	Reject	Mark
20 (b)	 Allow all dots or all crosses ALLOW ionic dot and cross  Or dative covalent bond from chlorine 		1

Question Number	Acceptable Answers	Reject	Mark
20 (c)	$HCl + HOCl \rightarrow H_2O + Cl_2$ **(1)** Ignore state symbols even if incorrect Chlorine is toxic/poisonous **(1)** Allow fumes are toxic Ignore references to smell or colour	 Just 'Harmful/ irritant/dangerous/ hazardous'	2

Question Number	Acceptable Answers	Reject	Mark
20 (d)(i)	(2NaOH + Cl_2 → NaCl + NaClO + H_2O) 0 -1 **+**1 All oxidation numbers correct **(1)** Type: Disproportionation **(1)** Allow phonetic spellings Allow redox **and** disproportionation Second mark consequential on the first except if (i) all the oxidation numbers are zero (ii) the plus sign is missing, (iii) the first two oxidation numbers are correct and the third one is positive If all the elemental oxidation numbers are given correctly then both marks are available	 Just redox	2

Question Number	Acceptable Answers	Reject	Mark
20 (d)(ii)	Heat/increase temperature ALLOW (more) concentrated NaOH	Just 'warm' / 'excess NaOH' Acid	1

Question Number	Acceptable Answers	Reject	Mark
20 (d)(iii)	$3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$ OR $3Cl_2 + 6OH^- \rightarrow 5Cl^- + ClO_3^- + 3H_2O$ Formula of $NaClO_3$ / ClO_3^- **(1)** Rest of equation correct **(1)** Ignore state symbols even if incorrect		2

TOTAL FOR Q20 = 16 MARKS

Question Number	Acceptable Answers	Reject	Mark
21 (a)(i)	**C-F** bond is strong(er than C-Cl bond/C-OH bond) OR **C-F** bond is hard(er) to break (than C-Cl bond/C-OH bond) OR **C-F** bond enthalpy is high(er than C-Cl bond/C-OH bond) Ignore references to electronegativity	H-F bond is strong	1

Question Number	Acceptable Answers	Reject	Mark
21 (a)(ii)	The C-Cl dipole is the wrong way round **(1)** Allow reference to either only the carbon or only the chlorine having the wrong partial charge, e.g. "the carbon should be δ^+ not δ^-" The arrow goes from the carbon to the (oxygen of the) hydroxide ion but should be the other way around OR The pair of electrons goes from the carbon to the (oxygen of the) hydroxide ion but should be the other way around **(1)** Use of the term 'carbocation' means that only one of the first two marks may be awarded. The carbon bond to the hydroxy group should be to the oxygen and not to the hydrogen **(1)** Allow the above points to be drawn out correctly instead of stated in words Standalone marks IGNORE δ^- on fluorine atom Reference to lack of transition state Reference to absence of lone pair of electrons on the hydroxide ion	C+ Cl^- OH **group** Hydroxide	3

Question Number	Acceptable Answers	Reject	Mark
21 (a)(iii)	$CH_3CHClF + OH^- \rightarrow CH_2CHF + Cl^- + H_2O$ Organic product **(1)** Rest of equation correct **(1)** The organic molecules can be drawn displayed Allow any suitable metal hydroxide, e.g. $CH_3CHClF + NaOH \rightarrow CH_2CHF + NaCl + H_2O$ Allow C_2H_3F for the organic product Ignore state symbols even if incorrect.	 CH_3CF	2

Question Number	Acceptable Answers	Reject	Mark
21 (b)	(i) Cl_2/chlorine (gas) **(1)** (ii) PCl_5/phosphorus (V) chloride **(1)** Allow Any other suitable reagents, such as HCl (and $ZnCl_2$) OR NaCl + concentrated H_2SO_4 OR $SOCl_2$ OR PCl_3 OR (concentrated) hydrochloric acid for (ii) (iii) HCl/hydrogen chloride **(1)** Ignore Reaction conditions	$Cl_2(aq)$/Cl• HCl(aq)	3

Question Number	Acceptable Answers	Reject	Mark
21 (c)(i)	$CH_3CH_2Cl + NH_3 \rightarrow CH_3CH_2NH_2 + HCl$ OR $CH_3CH_2Cl + NH_3 \rightarrow CH_3CH_2NH_3^{(+)}Cl^{(-)}$ OR $CH_3CH_2Cl + NH_3 \rightarrow CH_3CH_2NH_3^{(+)} + Cl^{(-)}$ OR $C_2H_5Cl + NH_3 \rightarrow C_2H_5NH_2 + HCl$ OR $CH_3CH_2Cl + 2NH_3 \rightarrow CH_3CH_2NH_2 + NH_4^{(+)}Cl^{(-)}$ OR $C_2H_5Cl + 2NH_3 \rightarrow C_2H_5NH_2 + NH_4^{(+)}Cl^{(-)}$	C_2H_7N	1

Question Number	Acceptable Answers	Reject	Mark
21 (c)(ii)	Nucleophilic **(1)** Substitution **(1)** ALLOW Just 'S_N2' for (1)	Elimination Addition S_N1	2

Question Number	Acceptable Answers	Reject	Mark
21 (c)(iii)	A **lone** pair (of electrons on the nitrogen atom)/ pair of non-bonding electrons	Pairs Just 'spare pair'	1

Question Number	Acceptable Answers	Reject	Mark
21 (c) (iv)	Ethanol / C_2H_5OH / CH_3CH_2OH	Alcohol	1

Question Number	Acceptable Answers	Reject	Mark
21 (d)(i)	Initiation $CCl_2F_2 \rightarrow CClF_2^{\bullet} + Cl^{\bullet}$ **(1)** --- Propagation 1 This must include a free radical from the initiation step reacting with ozone $Cl^{(\bullet)} + O_3 \rightarrow ClO^{(\bullet)} + O_2$ OR $CClF_2^{(\bullet)} + O_3 \rightarrow CClF_2O^{(\bullet)} + O_2$ **(1)** Propagation 2 $ClO^{(\bullet)} + O^{(\bullet)} \rightarrow Cl^{(\bullet)} + O_2$ OR $ClO^{(\bullet)} + O_3 \rightarrow Cl^{(\bullet)} + 2O_2$ **(1)** Allow propagation steps starting from $CClF_2^{\bullet}$ / $CClF_2O^{(\bullet)}$ or either of the equations from propagation 1 --- Termination $Cl^{\bullet} + Cl^{\bullet} \rightarrow Cl_2$ OR $CClF_2^{\bullet} + Cl^{\bullet} \rightarrow CCl_2F_2$ OR $ClO^{\bullet} + ClO^{\bullet} \rightarrow Cl_2 + O_2$ **(1)** Allow other combinations of free radicals using those shown above. Ignore curly arrows	Any charges	4

Question Number	Acceptable Answers	Reject	Mark
21 (d)(ii)	The depleted ozone layer allows in (more) **UV** (radiation) **(1)** Which results in (skin) cancer/cataracts/mutation/ DNA damage/ Any reference to a chain reaction/ One $Cl^{(\bullet)}$ destroys many ozone molecules/ $Cl^{(\bullet)}$ is regenerated/ $Cl^{(\bullet)}$ catalyst/ death of marine organisms such as phytoplankton **(1)** Standalone marks Any reference to greenhouse effect or global warming or infrared radiation scores (0)	Cancer from $Cl^{(\bullet)}$	2

Question Number	Acceptable Answers	Reject	Mark
21 (d)(iii)	(A greenhouse gas) traps/absorbs/reflects AND Infrared (radiation)/heat/ longer wavelength radiation OR Stops infrared (radiation) /heat escaping **(1)** (Reflected/(Re)radiated/(Re)emitted) **from the Earth**('s surface) Allow **Back** to the earth **(1)** Mention of ozone layer depletion/acid rain max 1	UV scores 0 overall. From the sun	2

Question Number	Acceptable Answers	Reject	Mark
21 (d)(iv)	Low concentration/amount/abundance in the atmosphere Short residency time	Just "they are no longer being used/they are not increasing".	1

TOTAL FOR Q21 = 23 MARKS
TOTAL FOR SECTION B = 39 MARKS

Section C

Question Number	Acceptable Answers	Reject	Mark
22 (a)	$Mg_2Si + 4HCl \longrightarrow 2MgCl_2 + SiH_4$ Correct formulae of products **(1)** Balancing of equation **(1)** Second mark dependent on first Ignore state symbols even if incorrect Allow one mark for the following equation $Mg_2Si + 4HCl \longrightarrow Mg_2Cl_4 + SiH_4$		**2**

Question Number	Acceptable Answers	Reject	Mark
22 (b)	Silicon dioxide/ SiO_2 /Silica **(1)** Water/H_2O **(1)** Allow names or formulae or both together but they both must be correct. Allow incorrect spellings if unambiguous Allow products to be given in an equation which does not have to be balanced.	Silicon oxide/ SiO CO_2 Silicone/Silicane dioxide H_2	**2**

Question Number	Acceptable Answers	Reject	Mark
22 (c)	Tetrahedral **(1)** $109.5^{(o)}$ **(1)**	 109°	**2**

Question Number	Acceptable Answers	Reject	Mark
22 (d)	Silicon (atom) is larger OR Because it has more shells of electrons **(1)** Weaker attraction/bond OR Greater shielding in silicon **(1)** Reverse argument applies in both marking points Stand-alone marks Ignore references to electronegativity/bond polarity	Ions/ionic radius Charge density Molecule Just 'more electrons' Reference to intermolecular forces	2

Question Number	Acceptable Answers	Reject	Mark
22 (e)	**Marking Point 1** London forces/Dispersion forces Temporary/instantaneous dipole induced dipole forces **(1)** ALLOW van der Waals forces **Marking Point 2** Silane/silicon has more electrons **(1)** **Marking Point 3** Silane has stronger/more London forces **(1)** **Marking Point 4** London forces are weak OR Little energy is required to break London forces (hence both are gases) **(1)** Ignore references to surface area	Dipole-dipole Induced dipole-induced dipole Hydrogen bonds Larger molar mass/ Great density of electrons/ larger electron cloud Break Si-H or C-H bonds	4

Question Number	Acceptable Answers	Reject	Mark
22 (f)(i)	The ability (of an atom) to attract/to pull/to draw the electrons **(1)** in/of a covalent bond Allow 'shared electron pair' **(1)** Allow species/element for atom		2

Question Number	Acceptable Answers	Reject	Mark
22 (f)(ii)	**Marking Point 1** In methane difference is 0.4 and silane difference is 0.3/Methane has a difference of 0.1 more than silane **(1)** **Marking Point 2** Hydrogen is more electronegative than silicon but less electronegative than carbon OR In methane, hydrogen will have a δ+ charge but in silane hydrogen will have a δ- charge OR The C-H bonds in methane are more polar (than the Si-H bonds in silane) **(1)** **Marking Point 3** The difference is small and so not significant, or has a minor effect **(1)** Ignore references to bond strength		3

Question Number	Acceptable Answers	Reject	Mark
22 (f)(iii)	Any suitable example and electronegativity difference scores 2 marks NH_3/H_2O/HF/HCl **(1)** 0.9/1.4/1.9/0.9 **(1)** Second mark consequential on the first, but if the formula is incorrect, e.g. HF_2, but the difference is correct of 1.9, then allow second mark. Allow one mark for an ionically-bonded hydride with a correct electronegativity difference greater than 0.4, e.g. NaH and 1.2 (1) Allow H_2S and the difference of 0.4 for 1 mark.	BH_3 / B_2H_6 / PH_3 scores 0	2

Question Number	Acceptable Answers	Reject	Mark
22 (f)(iv)	Bond polarities cancel in a symmetrical molecule/ centres of charge coincide in a symmetrical molecule OR Linking bond polarities cancelling due to the molecular shape which needs to be stated/drawn **(1)** Allow polar bonds for bond polarities Any suitable example, e.g. CCl_4/CO_2 / BF_3 / SF_6 **(1)** Allow CH_4 / SiH_4 Standalone marks	H_2	2

TOTAL FOR SECTION C (Question 22) = 21 MARKS

TOTAL FOR PAPER = 80 Marks

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