

Mark Scheme (Results)

Summer 2013

GCE Chemistry 6CH02/01
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. 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	D		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	A		1

Question Number	Correct Answer	Reject	Mark
5	C		1

Question Number	Correct Answer	Reject	Mark
6	B		1

Question Number	Correct Answer	Reject	Mark
7	C		1

Question Number	Correct Answer	Reject	Mark
8	A		1

Question Number	Correct Answer	Reject	Mark
9	B		1

Question Number	Correct Answer	Reject	Mark
10	D		1

Question Number	Correct Answer	Reject	Mark
11	D		1

Question Number	Correct Answer	Reject	Mark
12	B		1

Question Number	Correct Answer	Reject	Mark
13	B		1

Question Number	Correct Answer	Reject	Mark
14	C		1

Question Number	Correct Answer	Reject	Mark
15	A		1

Question Number	Correct Answer	Reject	Mark
16	B		1

Question Number	Correct Answer	Reject	Mark
17	D		1

Question Number	Correct Answer	Reject	Mark
18	A		1

Question Number	Correct Answer	Reject	Mark
19	C		1

Question Number	Correct Answer	Reject	Mark
20	C		1

Total for Section A = 20 Marks

Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	$\text{Ba(s)} + 2\text{H}_2\text{O(l)} \rightarrow \text{Ba(OH)}_2\text{(aq)} + \text{H}_2\text{(g)}$ <p>OR</p> $\text{Ba(s)} + 2\text{H}_2\text{O(l)} \rightarrow \text{Ba}^{2+}\text{(aq)} + 2\text{OH}^-\text{(aq)} + \text{H}_2\text{(g)}$ <p>Correct products (1)</p> <p>State symbols and balancing (1)</p>	Ba_2 $\text{H}_2\text{O(aq)}$ BaO_2	2

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	<p>Ba (increases in ON) from 0 to +2 (1)</p> <p>H (decreases in ON) from +1 to 0 (1)</p> <p>TE from (a)(i)</p> <p>Stand-alone marks</p>	<p>Inclusion of oxygen changes will lose 1 mark</p>	2

Question Number	Acceptable Answers	Reject	Mark
21(b)	$\text{Ba(OH)}_2 + 2\text{HCl} \rightarrow \text{BaCl}_2 + 2\text{H}_2\text{O}$ <p>IGNORE state symbols even if incorrect</p> <p>ALLOW</p> $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$ <p>TE from (a)(i):</p> $\text{BaO} + 2\text{HCl} \rightarrow \text{BaCl}_2 + \text{H}_2\text{O}$		1

Question Number	Acceptable Answers	Reject	Mark
21(c)	<p>White precipitate / white solid / white crystals (rather than colourless solution) (1)</p> <p>Barium sulfate is insoluble (whereas barium chloride is soluble) (1)</p> <p>Stand-alone marks</p>	'Cloudy' alone	2

Question Number	Acceptable Answers	Reject	Mark
21(d)(i)	<p>If flame test is described in (d)(i) then award appropriate marks for (d)(ii). A correct decomposition equation given in (d)(i) would score 1 mark.</p> <p>Allow valid discussion of thermal stability appearing in (d)(ii) for mark in (d)(i)</p> <p>Barium carbonate is more thermally stable (than magnesium carbonate) / requires more heating / needs a higher temperature / decomposes more slowly / produces carbon dioxide more slowly</p> <p>OR</p> <p>Reverse argument (MgCO_3 decomposes faster)</p> <p>ALLOW BaCO_3 doesn't decompose on heating but MgCO_3 does (1)</p> <p>$\text{MCO}_3 \rightarrow \text{MO} + \text{CO}_2$ Where M stands for Mg or Ba (1)</p> <p>IGNORE state symbols even if incorrect</p>	<p>Just 'barium'</p> <p>Just 'produces more carbon dioxide'</p> <p>Just 'magnesium'</p>	2

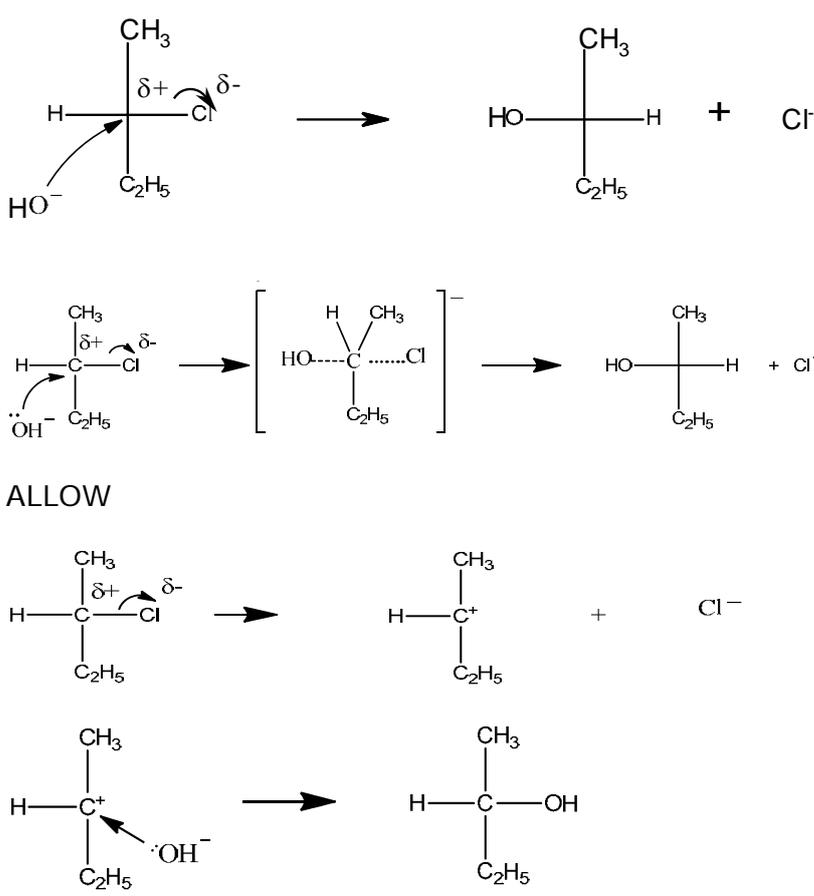
Question Number	Acceptable Answers	Reject	Mark
21(d)(ii)	<p>Flame test or description of: Mg does not colour flame (1) ALLOW colourless / clear</p> <p>Ba: (pale / apple) green flame (1)</p> <p>Stand-alone marks</p>	<p>Magnesium gives white / bright flame</p> <p>'blue-green'</p> <p>Instrument analysis</p>	2

Total for Question 21 = 11 Marks

Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	Alcohol /ethanol (as solvent for NaOH) IGNORE heat / pressure	Any other reagents	1

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	Elimination		1

Question Number	Acceptable Answers	Reject	Mark
22(a)(iii)	Water (as solvent for NaOH) / aqueous (NaOH) / aqueous (ethanol)	Aqueous silver nitrate	1

Question Number	Acceptable Answers	Reject	Mark
<p>22 (a) (iv)</p>	 <p>ALLOW</p> <p>Arrow from OH⁻ to appropriate C (connected / previously connected) to Cl (1)</p> <p>Arrow from C-Cl bond to Cl producing Cl⁻ (1)</p> <p>Accept three dimensional diagrams ; displayed formulae; CH₃CH₂ for C₂H₅ Use of C₄H₉Cl as formula can score 1 for arrow from C-Cl bond to Cl Lone pair on hydroxide ion need not be shown</p> <p>ALLOW solid lines instead of dotted lines in the transition state</p>	<p>OH without charge</p> <p>Cl[·] (chlorine radical)</p>	<p>2</p>

Question Number	Acceptable Answers	Reject	Mark
22(b)	Steamy / misty / white and fumes / gas (1) IGNORE fizzing $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3 + \text{PCl}_5 \rightarrow \text{CH}_3\text{CH}_2\text{CHClCH}_3 + \text{HCl} + \text{POCl}_3$ (1) ALLOW C ₄ H ₉ OH and C ₄ H ₉ Cl ALLOW PCl ₃ O Accept displayed formulae ALLOW missing bracket in alcohol Stand alone marks	White smoke Solid CH ₃ CH ₂ CH ₂ CH ₂ OH C ₄ H ₁₀ O	2

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	With butan-2-ol: (change from orange) to green / blue (1) With A : remains orange / no change (1) ALLOW 'no reaction' Any reference to 'yellow': max 1	Reference to gas given off or formation of precipitate Green-blue Just 'nothing'	2

Question Number	Acceptable Answers	Reject	Mark
22(c)(ii)	CH ₃ CH ₂ COCH ₃ ALLOW displayed or skeletal		1

Question Number	Acceptable Answers	Reject	Mark
22(c)(iii)	Absorption / peak / trough for O-H / C-O / OH bond / alcohol CO bond would disappear OR Absorption / peak / trough for C=O / CO ketone bond would appear	Just - OH / CO Just 'alcohol peak' Just 'ketone peak'	1

Total for Question 22 = 11 Marks

Question Number	Acceptable Answers	Reject	Mark
23(a)	London (forces) / van der Waals (forces) / temporary dipole-induced dipole (attractions) / dispersion forces / instantaneous dipole-dipole	Dipole-dipole Permanent dipole-dipole Just abbreviations, eg ID-ID, VdW	1

Question Number	Acceptable Answers	Reject	Mark
23(b)	18 /eighteen		1

Question Number	Acceptable Answers	Reject	Mark
23(c)	(Permanent) dipole-dipole attractions (also) present	Hydrogen bonds Reference to CH ₃ F having more electrons than F ₂	1

Question Number	Acceptable Answers	Reject	Mark
23(d)	Hydrogen bonds (also) present (1) Which are stronger / which require more energy to break than dipole-dipole / London forces / van der Waals' forces / Or strongest intermolecular force (1)		2

Question Number	Acceptable Answers	Reject	Mark
23(e)	HCl does not have hydrogen bonds (between molecules) IGNORE references to electronegativity	Just 'chlorine does not have hydrogen bonds'	US035563

Total for Question 23 = 6 Marks

Question Number	Acceptable Answers	Reject	Mark
24(a)(i)	<p>In (a) any units given must be correct. Penalise once only. IGNORE SF except 1SF. Penalise once only. TE throughout</p> <p>$((0.1 \times 11.6) / (1000)) = 1.16 \times 10^{-3} / 0.00116 / 0.0012 / 1.2 \times 10^{-3} (\text{mol})$</p>		1

Question Number	Acceptable Answers	Reject	Mark
24(a)(ii)	<p>$(1.16 \times 10^{-3} / 2) = 5.8 \times 10^{-4} / 0.00058 (\text{mol } I_2 \text{ react with thiosulfate})$ 6.0×10^{-4} if 1.2×10^{-3} used</p>	6×10^{-4}	1

Question Number	Acceptable Answers	Reject	Mark
24(a)(iii)	<p>$((50 \times 0.25) / 1000) = 1.25 \times 10^{-2} / 12.5 \times 10^{-3} / 0.0125 (\text{mol})$</p>	0.012	1

Question Number	Acceptable Answers	Reject	Mark
24(a)(iv)	<p>= Answer to (a)(iii) - answer to a(ii)</p> <p>$(1.25 \times 10^{-2} - 5.8 \times 10^{-4}) = 1.192 \times 10^{-2} / 0.01192 (\text{mol reacted with tin})$</p> <p>$1.19 \times 10^{-2} / 0.0119 (\text{mol})$ if 6.0×10^{-4} used</p> <p>ALLOW $1.2 \times 10^{-2} / 0.012 (\text{mol})$</p>	1.20×10^{-2}	1

Question Number	Acceptable Answers	Reject	Mark
24(a)(v)	<p>Mass of tin = answer to (a)(iv) $\times 118.7 /$</p> <p style="text-align: right;">$= 1.414904 / 1.415 \text{ g} \quad \mathbf{(1)}$</p> <p style="text-align: center;">$\% \text{ tin} = \frac{(1.415 \times 100)}{10.25} = 13.803941$</p> <p style="text-align: right;">$= 13.8 \% \quad \mathbf{(1)}$</p> <p>TE from mass if only 1 error in its calculation</p> <p>13.83/ 13.8% if 1.194×10^{-2} used</p> <p>If answer to (a)(iv) = $5.8 \times 10^{-4} \text{ mol } I_2$ this gives 0.068846 g Sn and 0.67167 % Sn scores (2)</p> <p>Correct answer without working scores (2)</p> <p>ALLOW (1) for 17.5% of SnO_2</p>		2

Question Number	Acceptable Answers	Reject	Mark
24(b)(i)	Divide solution into separate portions for titration	Just 'repeat the titration' Use starch	1

Question Number	Acceptable Answers	Reject	Mark
24(b)(ii)	$\frac{(0.05 \times 2 \times 100)}{11.6} = (\pm) 0.86\%$ ALLOW 0.9%	0.90%	1

Question Number	Acceptable Answers	Reject	Mark
24(b)(iii)	Use more dilute thiosulfate (to make titration reading bigger) / Use a larger volume or moles of excess iodine	Use more rock	1

Question Number	Acceptable Answers	Reject	Mark
24(c)	(Pale) yellow / straw-coloured to colourless	Clear for colourless Blue / black to colourless Orange / grey / brown	1

Total for Question 24 = 10 Marks

Question Number	Acceptable Answers	Reject	Mark
25(a)(i)	<p>2.2 g in 1000 g = 2200 g per 1 000 000 g / 2200 (ppm) (greater than 60)</p> <p>OR</p> <p>60ppm = 0.060 (g dm⁻³) (less than 2.2)</p> <p>OR</p> <p>2.2g dm⁻³ = 0.22% which is more than 60ppm = 0.006% (Both values needed as neither is given in question)</p> <p>OR</p> <p>$2.2 \div 1000 = 2.2 \times 10^{-3}$ and $60 \div 1000000 = 6 \times 10^{-5}$</p>		1

Question Number	Acceptable Answers	Reject	Mark
25(a)(ii)	<p>$\text{Cl}_2 (\text{g/aq}) + 2\text{Br}^- (\text{aq}) \rightarrow 2\text{Cl}^- (\text{aq}) + \text{Br}_2 (\text{aq})$</p> <p>Correct species (1)</p> <p>Balancing and state symbols (1)</p>		2

Question Number	Acceptable Answers	Reject	Mark
25(a)(iii)	(Colourless to) yellow / orange / brown / red-brown colour (or any combination of these colours) appears	'Effervescence'	1

Question Number	Acceptable Answers	Reject	Mark
25(a)(iv)	<p>Addition of hydrochloric acid increases the concentration of H⁺ (1)</p> <p>Equilibrium shifts to the left/ favours the backwards reaction / H⁺ combines with Br⁻ and BrO⁻ to make H₂O and Br₂ (1)</p> <p>OR</p> <p>The equilibrium will not produce H⁺ (1)</p> <p>So forward reaction will not occur (1)</p> <p>Standalone marks</p>		2

Question Number	Acceptable Answers	Reject	Mark
25(a)(v)	The equilibrium shifts to the right / favours the forward reaction (1) To absorb added heat (energy) / in the endothermic / positive ΔH direction (1)		2

Question Number	Acceptable Answers	Reject	Mark
25(a)(vi)	Greater proportion of / more molecules with energy more than (or equal to) activation energy / sufficient energy to react (at higher temperature) ALLOW particles. ALLOW 'overcome' for 'more than'.	Atoms Lowers activation energy Just 'more successful collisions'	1

Question Number	Acceptable Answers	Reject	Mark
25(a)(vii)	Bromine (atoms) are (simultaneously) oxidized from 0 to +1 in BrO^- (1) And reduced to -1 in Br^- (1)		2

Question Number	Acceptable Answers	Reject	Mark
25(b)(i)	The forward and backward reactions occur at the same rate (1) The concentrations or amounts or moles of reactants and products remain constant / intensive or macroscopic properties (e.g. colour) are constant (1) IGNORE reference to 'closed system'	Concentrations of products and reactants are the same	2

Question Number	Acceptable Answers	Reject	Mark
25(b)(ii)	Equilibrium shifts to the right so more $\text{CO}_2(\text{g})$ dissolves / equilibrium shifts to the right so reducing the concentration of $\text{CO}_2(\text{aq})$ (1) So amount of CO_2 in atmosphere / gaseous decreases (1) Second mark depends on first unless qualified by a near miss		2

Question Number	Acceptable Answers	Reject	Mark
25(b)(iii)	(Bonds) bend / stretch / vibrate (more)/ bonds change polarity or dipole (moment)	Molecules vibrate Bonds break.	1

Question Number	Acceptable Answers	Reject	Mark
25(b)(iv)	<p>Infrared radiation / heat is absorbed by greenhouse gases / by carbon dioxide and water (1)</p> <p>And one of the following:</p> <p>When energy from the sun is (re-)emitted from the earth's surface (allow 'reflected')</p> <p>OR</p> <p>IR / heat cannot escape from earth's atmosphere</p> <p>OR</p> <p>IR / heat is (re-)emitted back to the earth (1)</p>	<p>IR absorbed from the sun</p> <p>UV radiation</p>	2

Question Number	Acceptable Answers	Reject	Mark
25(b)(v)	<ul style="list-style-type: none"> • Anthropogenic climate change is caused by human activity (1) • Natural climate change is caused by volcanic eruptions etc (1) <p>Up to any three of the following to a max of (4)</p> <ul style="list-style-type: none"> • Water vapour levels always relatively constant / water levels fluctuate normally / water levels vary only to a small extent • CO₂ levels increasing due to (fossil) fuel combustion/deforestation / industrial revolution • CO₂ molecules absorb more IR radiation than H₂O molecules OR CO₂ molecules have a greater 'greenhouse effect' than H₂O molecules • Increase in CO₂ levels has accompanied rise in global temperatures • Concern due to melting of ice packs / rising sea levels / flooding / change in sea pH etc 	<p>Reference to UV</p> <p>Reference to ozone depletion negates this mark</p>	4

Total for Question 25 = 22 Marks

Total for Paper = 80 Marks

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