



Mark Scheme (Results)

January 2013

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. 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	C		1

Question Number	Correct Answer	Reject	Mark
2	B		1

Question Number	Correct Answer	Reject	Mark
3	D		1

Question Number	Correct Answer	Reject	Mark
4	C		1

Question Number	Correct Answer	Reject	Mark
5	D		1

Question Number	Correct Answer	Reject	Mark
6	A		1

Question Number	Correct Answer	Reject	Mark
7	A		1

Question Number	Correct Answer	Reject	Mark
8	B		1

Question Number	Correct Answer	Reject	Mark
9	A		1

Question Number	Correct Answer	Reject	Mark
10	C		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	C		1

Question Number	Correct Answer	Reject	Mark
14	D		1

Question Number	Correct Answer	Reject	Mark
15	D		1

Question Number	Correct Answer	Reject	Mark
16	A		1

Question Number	Correct Answer	Reject	Mark
17	B		1

Question Number	Correct Answer	Reject	Mark
18	A		1

Question Number	Correct Answer	Reject	Mark
19	B		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)	<p>First two marks</p> <p>Cl in Cl₂ is 0 Goes to +1 in HClO Goes to -1 in HCl</p> <p style="text-align: right;">(2)</p> <p>All three correct for two marks Any two correct for one mark Ignore correct oxidation numbers for other elements If three correct numbers given without saying what species they are in max 1 for these two marks</p> <p>Third mark</p> <p>Cl/Cl₂/the same element is both oxidized and reduced Allow same molecule/species/ type of atom is both oxidized and reduced if answer elsewhere has been in terms of chlorine</p> <p>OR</p> <p>Cl/Cl₂/the same element both increases and decreases in oxidation number</p> <p>OR</p> <p>Chlorine both loses and gains electrons (1)</p>	<p>Only 'Cl⁺' for oxidation number +1</p> <p>Only 'Cl⁻' for oxidation number -1 (treat each separately)</p> <p>For each incorrect oxidation number change for O and H, lose one mark.</p> <p>0 to +1 described as reduction and/or 0 to -1 described as oxidation (for third mark)</p>	3

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	<p>Equilibrium moves to the left / moves in reverse direction / moves to increase concentration of reactants (1)</p> <p>To use up (some of) added HCl/ to react with added HCl/ to stop formation of HCl/ restores equilibrium by producing more chlorine and water (1)</p> <p>Second mark depends on first</p> <p>Allow 'moves to decrease concentration of products/HCl' for both marks</p>	<p>Just "reverse reaction is favoured"</p> <p>Just "to counteract the change in the system" To minimise effect of HCl</p>	2

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	$\text{ClO}^- + 2\text{H}^+ + 2\text{e}^{(-)} \rightarrow \text{Cl}^- + \text{H}_2\text{O}$ <p>ALLOW</p> $\text{ClO}^- + 2\text{H}^+ \rightarrow \text{Cl}^- + \text{H}_2\text{O} - 2\text{e}^{(-)} \quad (1)$ $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^{(-)}$ <p>ALLOW</p> $2\text{I}^- - 2\text{e}^{(-)} \rightarrow \text{I}_2 \quad (1)$ <p>Allow multiples</p> <p>Ignore state symbols even if incorrect</p>	Equations without electrons	2

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	$\text{ClO}^- + 2\text{H}^+ + 2\text{I}^- \rightarrow \text{Cl}^- + \text{H}_2\text{O} + \text{I}_2$ <p>Mark independently. No TE on 21(b)(i)</p>	Equations including electrons	1

Question Number	Acceptable Answers	Reject	Mark
21(b)(iii)	<p>Moles thiosulfate = $(24.20 \times 0.0500 / 1000) = 1.21 \times 10^{-3} / 1.2 \times 10^{-3} / 0.00121 / 0.0012$ (mol) (1)</p> <p>Moles iodine = half moles of thiosulfate = $6.05 \times 10^{-4} / 6.1 \times 10^{-4} / 0.000605 / 0.00061$ (mol) (1)</p> <p>Correct answer without working (2)</p>	1.20×10^{-3} (mol) $1 \times 10^{-3} / 0.001$ 6.0×10^{-4} (mol) 6×10^{-4} (mol)	2

Question Number	Acceptable Answers	Reject	Mark
21(b)(iv)	<p>Moles $\text{ClO}^- = 6.05 \times 10^{-4}$ (mol)</p> <p>TE on (b)(ii) and (b)(iii):</p> <p>If ratio $\text{ClO}^- : \text{I}_2 = 2:1$ answer is 2 x answer to (b)(iii)</p> <p>If ratio $\text{ClO}^- : \text{I}_2 = 1:2$ answer is half of answer to (b)(iii)</p>		1

Question Number	Acceptable Answers	Reject	Mark
21 (b) (v)	Concentration = $(6.05 \times 10^{-4} \times 1000/25)$ $= 2.42 \times 10^{-2} / 0.0242/ 0.024/ 2.4 \times 10^{-2}$ (mol dm ⁻³) TE. Answer to (b)(iv) $\times 1000 \div 25$	Answers to 1 significant figure	1

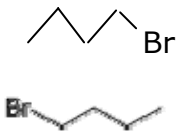

Question Number	Acceptable Answers	Reject	Mark
21 (b) (vi)	(Minimum) amount of I ⁻ to react with OCl ⁻ $= 2 \times$ answer to (b)(iv) $= 2 \times 6.05 \times 10^{-4}$ $= 1.21 \times 10^{-3}$ (mol) (1) Allow TE for $2 \times$ answer to (b)(iv) Ignore s.f. Moles of I ⁻ (9.04×10^{-3}) is more than this number of moles of ClO ⁻ / I ⁻ is in excess / KI is in excess / so that all the ClO ⁻ can react (1) OR 9.04×10^{-3} mol I ⁻ can react with 4.52×10^{-3} mol OCl ⁻ (1) Ignore s.f. TE from incorrect equation in (b)(ii) Moles OCl ⁻ (6.05×10^{-4}) is less than this/ I ⁻ is in excess / KI is in excess / so that all the ClO ⁻ can react (1)	"KI is in excess" if no calculation has been done.	2

Question Number	Acceptable Answers	Reject	Mark
21 (b) (vii)	$0.30 \times 100 / 24.2$ (=1.2396694) $= 1.24/ 1.2 \%$		1

Question Number	Acceptable Answers	Reject	Mark
21(b)(viii)	<p>Judgement (of colour change) at end point / adding starch too early in the titration / jet of burette not filled</p> <p>Errors must cause an increase in titre.</p> <p>Ignore</p> <p>Just "Human error"</p> <p>Just 'overshot endpoint'</p> <p>Transfer errors / spillage</p> <p>Errors due to misreading burette / pipette</p>	<p>Some potassium iodide did not dissolve</p> <p>Leaving funnel in burette</p> <p>Errors which affect both the students titre and an accurate titre using the same solutions e.g. impure solutions</p>	1

Question Number	Acceptable Answers	Reject	Mark
21(c)	<p>(Cl radicals) break down ozone (layer)/ ozone depletion / ozone (layer) thinning</p> <p>Allow damage ozone (layer)/ react with ozone</p>	<p>Global warming</p> <p>Causes acid rain</p>	1

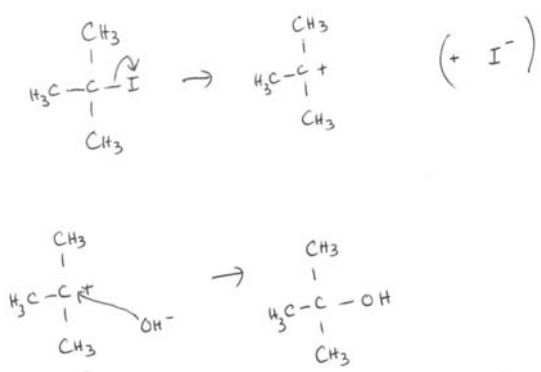
Total for Q21 = 17 marks

Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	 <p>Allow the bond to Br to be before or after the zig-zag line representing the 4C atoms, and to be at any angle Ignore bonds of unequal length</p>		1

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	<p>2-iodo-(2-)methylpropane</p> <p>Accept (2-)methyl-2-iodopropane</p> <p>Ignore punctuation (brackets, hyphens, commas)</p>	<p>2,2-iodomethylpropane</p> <p>2-iodobutane</p>	1

Question Number	Acceptable Answers	Reject	Mark
22(a)(iii)	<p>$C_4H_9Br + 2NH_3 \rightarrow C_4H_9NH_2 + NH_4Br$</p> <p>OR</p> <p>$C_4H_9Br + NH_3 \rightarrow C_4H_9NH_2 + HBr$</p> <p>OR</p> <p>$C_4H_9Br + NH_3 \rightarrow C_4H_9NH_3^{(+)}Br^{(-)}$ (1)</p> <p>Accept structural / skeletal formula for X and product Allow inorganic product as ions</p> <p>Butylamine / 1-aminobutane / 1-butylamine/ 1-butanamine/ butan-1-amine (1)</p> <p>Ignore incorrect spacing and punctuation</p> <p>OR</p> <p>(N) butyl ammonium bromide if third equation given (1)</p> <p>OR</p> <p>Answers with multiple substitutions giving (C_4H_9)₂ NH (1) dibutylamine (1) (C_4H_9)₃ N (1) tributylamine (1) (C_4H_9)₄ N⁽⁺⁾ Br⁽⁻⁾ (1) tetrabutyl ammonium bromide (1)</p> <p>No TE on naming a product in an incorrect equation except if C_4H_8 is shown in a correct or incorrect elimination equation then 1 mark for naming it but-1-ene</p>	<p>Just word equations</p> <p>Molecular formula for organic product i.e. $C_4H_{11}N$</p> <p>Equation for elimination reaction</p> <p>Aminobutane</p> <p>Butamine</p> <p>Any amide</p>	2

	If correct equation and name (e.g. 2-amino-2-methylpropane) are given using Y max 1		
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Question Number	Acceptable Answers	Reject	Mark
22 (a)(iv)	 <p>Arrow to I from within C-I bond (1) Formula of carbocation (1) Arrow from OH⁻ to C⁺ (1)</p> <p>If both arrows are shown before formation of intermediate max 2</p> <p>Charge on OH⁻ essential for third mark. Lone pair need not be shown. Ignore partial charges on C and I in Y</p> <p>Ignore arrows showing hydroxide ion formation in KOH / covalent KOH Ignore K⁺ ions combining with I⁻ / inorganic products Mechanism for X instead of Y Max 2</p> <p>Correct SN2 mechanism can score first mark and third mark for arrow from OH⁻ to C^(δ+)</p>	<p>Half arrows, but don't penalise twice</p> <p>δ⁺ charge on intermediate</p>	3

Question Number	Acceptable Answers	Reject	Mark
22(a)(v)	(Nucleophilic) elimination (reaction) (of HI)	<p>Electrophilic elimination</p> <p>Nucleophilic substitution</p> <p>Dehydration</p>	1

Question Number	Acceptable Answers	Reject	Mark
22(b)	<p>X Cream precipitate Allow off white / creamy white / white-cream / (very) pale yellow (1)</p> <p>Y yellow precipitate (1)</p> <p>One mark for two correct colours but not precipitates Mention of precipitate without colours doesn't score Ignore identity of precipitates even if incorrect</p>	<p>Yellow/ creamy yellow precipitate for X</p> <p>Pale yellow precipitate for Y</p>	2

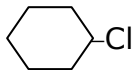
Question Number	Acceptable Answers	Reject	Mark
22(c)	<p>C-Br stronger / C-I weaker with an attempt at an explanation (correct or incorrect) (1)</p> <p>as bond is shorter/ Br (atom) is smaller / as nuclei are closer</p> <p>OR reverse argument (1)</p> <p>Allow Br is more electronegative/ there is a bigger electronegativity difference / bond is more polar / $C^{\delta+}$ and $Br^{\delta-}$ attract more strongly / Br is less shielded</p> <p>Second mark depends on first</p>	<p>Br_2 is smaller</p> <p>References to Br^- implying bond is ionic.</p> <p>Br is more reactive</p>	2

Total for Q22 = 12 marks

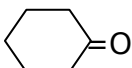
Question Number	Acceptable Answers	Reject	Mark
23(a)(i)	109 (°) / 109.5 (°) / 109° 28'		1

Question Number	Acceptable Answers	Reject	Mark
23(a)(ii)	<p>104 – 106 (°) (1)</p> <p>O atom has two lone pairs (and 2 bonding pairs) (1) This mark can be given independently of the first and third mark</p> <p>Lone pairs repel each other more than bonding pairs / angle is reduced to minimise repulsion (by lone pairs) / to maximise separation (of lone pairs) (1)</p> <p>Ignore 'bonds repel each other'</p> <p>Angle in (ii) must be smaller than in (i) for third mark to be given</p>	Lone pairs repel H atoms	3

Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	<p>Any two from Fizzing / effervescence / bubbles (of gas) (1)</p> <p>Sodium dissolves / disappears / reduces in size (1)</p> <p>White solid /precipitate forms (1)</p> <p>Ignore identification of products even if incorrect.</p> <p>Ignore sodium melting / moving around / sinking / floating</p> <p>Ignore colourless solution forms</p> <p>Ignore temperature changes / sodium going on fire</p>	<p>Just "Hydrogen forms"/"gas forms"</p> <p>Fumes</p>	2

Question Number	Acceptable Answers	Reject	Mark
23(b)(ii)	$\text{C}_6\text{H}_{11}\text{OH} + \text{PCl}_5 \rightarrow \text{HCl} + \text{C}_6\text{H}_{11}\text{Cl} + \text{POCl}_3$ <p style="text-align: center;">(1) (1)</p> <p>(1) for HCl (1) for rest of the equation correct</p> <p>Cyclohexanol can be skeletal, $\text{C}_6\text{H}_{11}\text{OH}/$ $\text{C}_6\text{H}_{12}\text{O}$</p> <p>Accept 'PCl₃O' instead of POCl₃ Accept skeletal formula for $\text{C}_6\text{H}_{11}\text{Cl}$</p>  <p>Ignore state symbols</p>	<p>$\text{C}_5\text{H}_{11}\text{COH}$</p> <p>$\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CHOH}$ Unless a bond is shown connecting C1 and C6</p>	2

Question Number	Acceptable Answers	Reject	Mark
23(b)(iii)	<p>White smoke / solid with ammonia Allow white fumes / dense white fumes / steamy white fumes OR White precipitate with silver nitrate</p> <p>Ignore reference to ammonia solution unless HCl is specifically bubbled into solution</p> <p>Ignore using an indicator to show gas is acidic with one of the above tests</p> <p>Ignore description of appearance of HCl before testing</p>	<p>Just steamy / misty fumes</p> <p>Just testing with an indicator</p> <p>Bleaches litmus</p>	1

Question Number	Acceptable Answers	Reject	Mark
23(b)(iv)			1

Question Number	Acceptable Answers	Reject	Mark
23(b)(v)	(Colour change from) Orange to green / blue / brown	blue- green green-blue yellow to green	1


Question Number	Acceptable Answers	Reject	Mark
23(c)	$C_6H_{10}^{(+)}$	$C_6H_{10}^-$ $(CH_2)_5C$ $C_5H_{10}C$ C_6H_{11} $(CH)_5OH$ $C_2(CH_2)_3O$	1

Total for Q23 = 12 marks

Question Number	Acceptable Answers	Reject	Mark
24(a)	<p>CO₂ has polar bonds / oxygen does not have polar bonds (1)</p> <p>Ignore O₂ is a non polar molecule</p> <p>(As it vibrates) polarity of CO₂ changes / dipole moment changes / shifts (1)</p> <p>Allow "Oxygen has no difference in electronegativity so polarity does not change" for 2 marks</p>	CO ₂ is a polar molecule	2

Question Number	Acceptable Answers	Reject	Mark
24(b)(i)	<p>Hydrogen bonds can form with water</p> <p>Allow full description of hydrogen bonds in absence of name.</p> <p>Ignore incorrect naming of functional groups in aminoethanol.</p>	Just "it is polar"	1

Question Number	Acceptable Answers	Reject	Mark
24(b)(ii)	<p>Exothermic, with attempt at a reason OR reverse reaction is endothermic, with attempt at a reason (1)</p> <p>Reaction will go in the endothermic direction on heating / equilibrium moves to left to use up heat supplied (1)</p> <p>Second mark depends on the reaction being exothermic in first mark</p>	Just "exothermic"	2

Question Number	Acceptable Answers	Reject	Mark
24(c)(i)	 <p>Electrons in double bond (1) Other electrons (1)</p> <p>Second mark dependent on first</p> <p>Only bonding electrons need be shown If inner shell electrons are included they must be correct.</p> <p>Electrons may be on circles, within circles or no circles may be shown.</p>		2

Question Number	Acceptable Answers	Reject	Mark
24(c)(ii)	<p>Number of electrons (per molecule) is greater in CO₂ (than methane).</p> <p>If numbers are given must be correct. CO₂ has 22e⁻, methane has 10e⁻.</p> <p>Ignore CO₂ has larger surface area than methane</p>	double bonds in CO ₂ as the cause	1

Question Number	Acceptable Answers	Reject	Mark
24(c)(iii)	<p>Butane has a greater surface area / butane is less branched (1)</p> <p>so more contact between (neighbouring) molecules / (neighbouring) molecules pack better (1)</p> <p>OR</p> <p>Reverse argument for 2-methylpropane</p>		2

Question Number	Acceptable Answers	Reject	Mark
24(d)(i)	<p>Mg – no colour in flame (1)</p> <p>Allow 'no flame visible'</p> <p>Ca brick red / red / yellow-red / red-orange (1)</p>	<p>Mg: white flame Bright / white light Clear flame</p> <p>Just orange</p>	2

Question Number	Acceptable Answers	Reject	Mark
24(d)(ii)	<p>First mark: Detect thermal decomposition by</p> <p>Passing gas into / reacting gas with lime water OR By collecting the gas evolved (in syringe or by displacement) OR By measuring change of mass (1)</p> <p>Second mark: Measure time for (same volume) of lime water to go milky OR Measure volume of gas produced in a measured time OR Measure time for a specified / same volume of gas to form OR Find loss of mass after heating samples for equal time (1)</p> <p>The mark for measurement should only be given if it matches the suggested method of detection.</p> <p>Third and fourth marks: For fair comparison Any two from: Keep strength of flame constant (1)</p> <p>Distance of flame from containing tube constant (1)</p> <p>Use carbonates with similar particle size (1)</p> <p>Same volume of lime water (1)</p> <p>Heat equal moles / same amount of each carbonate (1)</p> <p>Judge equal milkiness of lime water using a piece of paper marked with a cross (1) The marks for fair comparison should only be given if they match the suggested method of detection.</p> <p>Ignore 'heat same mass' and 'known mass' Ignore using water bath as source of heat</p>	<p>First mark: Combustion Heating carbonate solution</p> <p>Second mark:</p> <p>Just "measure volume of gas produced"</p> <p>Measure time for a specified change in mass to occur</p>	4

	<p>Ignore 'heat to same temperature' Ignore 'use same heat source' Ignore 'constant heat'</p> <p>These points could be shown on a diagram but marks are for the principles, not the detail of drawing a sketch diagram.</p>		
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Question Number	Acceptable Answers	Reject	Mark
24(d)(iii)	<p>CaCO₃ more stable / MgCO₃ less stable (1)</p> <p>Mg²⁺ is smaller than Ca²⁺ / magnesium ions are smaller than calcium ions / charge density of Mg²⁺ is greater than Ca²⁺ / Ca²⁺ has more shells (1)</p> <p>EITHER Mg²⁺ causes more distortion of carbonate ion / more weakening of C-O / more polarisation of carbonate / more polarisation of anion / has more polarising power</p> <p>OR More energy is given out when MgO forms as the MgO lattice is stronger than CaO / as the 2+ ions can get closer to the 2⁻ ions on decomposition (1)</p> <p>Second and third marks can be scored if conclusion given in first mark is wrong</p>	<p>Mg is smaller "It" (unspecified) is smaller MgCO₃ is smaller</p> <p>More disruption of ion</p> <p>Polarisation of carbonate molecules</p> <p>CaO is less stable than MgO</p>	3

Total for Q24 = 19 marks

TOTAL FOR SECTION B = 60 MARKS

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