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Mark Scheme (Results)

Summer 2015

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	Mark
1	D	1

Question Number	Correct Answer	Mark
2	B	1

Question Number	Correct Answer	Mark
3	C	1

Question Number	Correct Answer	Mark
4	C	1

Question Number	Correct Answer	Mark
5	B	1

Question Number	Correct Answer	Mark
6	D	1

Question Number	Correct Answer	Mark
7	D	1

Question Number	Correct Answer	Mark
8	A	1

Question Number	Correct Answer	Mark
9	B	1

Question Number	Correct Answer	Mark
10(a)	B	1
(b)	D	1
(c)	A	1
(d)	D	1

Question Number	Correct Answer	Mark
11	D	1

Question Number	Correct Answer	Mark
12	A	1

Question Number	Correct Answer	Mark
13	C	1

Question Number	Correct Answer	Mark
14	C	1

Question Number	Correct Answer	Mark
15	D	1

Question Number	Correct Answer	Mark
16	A	1

Question Number	Correct Answer	Mark
17	C	1

Section B

Question Number	Acceptable Answers	Reject	Mark
18 (a)(i)	Ethanol dissolves silver nitrate / silver ions and halogenoalkanes OR Ethanol (molecule) is polar and non-polar (solvent) OR Ethanol dissolves ionic and covalent compounds ALLOW Ethanol dissolves ionic and non-polar compounds Ethanol dissolves both types (of compound) So that the reactants can mix 'miscible' for 'dissolves' IGNORE Any references to rate	Ethanol is non-polar Just 'ethanol dissolves halogenoalkanes' Just 'water does not dissolve halogenoalkanes' Just 'they dissolve in ethanol'	1

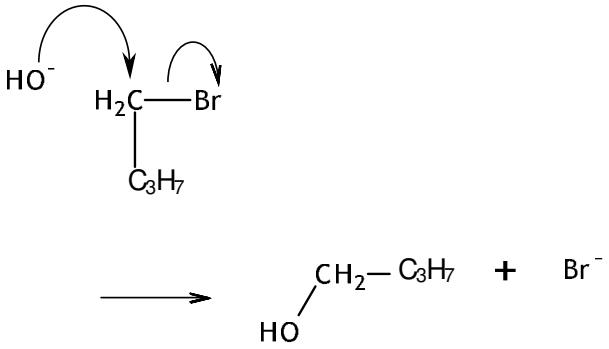
Question Number	Acceptable Answers	Reject	Mark
18(a)(ii)	To allow the temperature (of all the liquids) to equilibrate / to reach 50°C OR So that all the substances are at the same temperature ALLOW So that the temperature is constant		1

Question Number	Acceptable Answers	Reject	Mark
18(a)(iii)	Silver bromide IGNORE Formula even if incorrect (1) $Ag^+ + Br^- \rightarrow AgBr$ (1) TE on incorrect silver halide ALLOW Ionic equations with uncancelled ions Ag^+Br^- as product IGNORE state symbols even if incorrect	Non-ionic equations	2

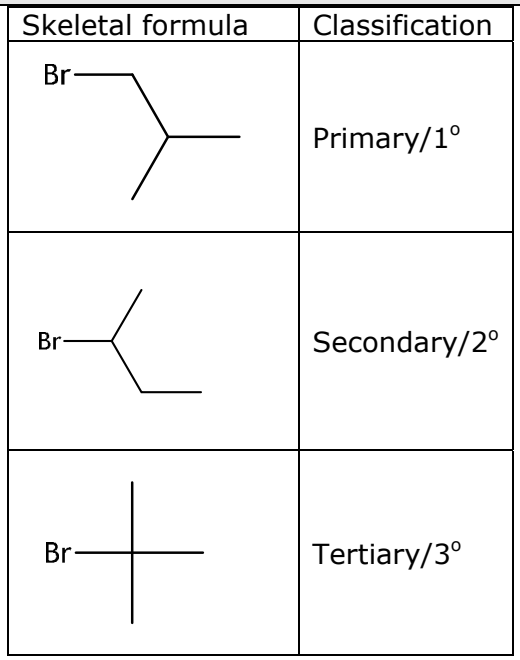
Question Number	Acceptable Answers	Reject	Mark
18(a)(iv)	Order: iodo, bromo, chloro ALLOW AgI, AgBr, AgCl OR I, Br, Cl OR Iodine, bromine, chlorine (1) C—I is the weakest bond OR I^- is best leaving group ALLOW (if MP1 awarded) Rate depends on the strength of the C—X bond (1) IGNORE Explanations of the bond strengths, even if incorrect. References to bond length and atomic radius/size ALLOW Reverse argument for MP2	 I_2, Br_2, Cl_2 Rate depends on the reactivity of X / X^-	2

Question Number	Acceptable Answers	Reject	Mark
18(b)(i)	nucleophilic (1) substitution (1) Stand alone marks S_N2 alone scores one mark	 S_N1	2

Question Number	Acceptable Answers	Reject	Mark
18(b)(ii)	Some comparison is required. Hydroxide ion /OH^- is a stronger nucleophile (than water) ALLOW OH^- is a better electron pair donor (than water) Concentration of hydroxide ion / OH^- is higher OR Hydroxide ion / OH^- is charged More hydroxide ion / OH^- in NaOH (than water) IGNORE OH^- is more basic / alkaline Alkali is a stronger nucleophile OH^- is more reactive ALLOW Reverse argument	 Use of NaOH/OH for OH^- Just 'NaOH/alkali forms OH^- more readily'	1

Question Number	Acceptable Answers	Reject	Mark
18 (b)(iii)	Penalise omission of charge on hydroxide ion once only (in MP2) First mark  Both curly arrows First curly arrow from any part of the hydroxide ion (or the charge) to the carbon atom Second curly arrow from the C—Br bond to the bromine atom or just beyond (1) Second mark Lone pair on oxygen of OH^- {HO:} (1) Third mark Partial charge on C—Br bond { $C^{\delta+}$—$Br^{\delta-}$} (1) ALLOW Correct S_N1 mechanism for full marks Curly arrow from hydroxide group from any part of the group including the charge. IGNORE transition state (even if incorrect) products (even if incorrect)	OH with no / partial charge C^+—Br^-	3

Question Number	Acceptable Answers	Reject	Mark
18(b)(iv)	PCl_5: misty /steamy /white fumes/gas IGNORE Tests on product (e.g. turns blue litmus red) (1) $K_2Cr_2O_7$: orange solution turns green ALLOW Orange to blue (1) $K_2Cr_2O_7$ preferred because PCl_5 reacts with water (as well as alcohols) ALLOW $K_2Cr_2O_7$ preferred because PCl_5 reacts with alkali / OH^- /OH (1) IGNORE References to primary, secondary and tertiary alcohols	smoke Just 'fumes'/ 'effervescence' PCl_5 reacts with carboxylic acids	3

Question Number	Acceptable Answers	Reject	Mark
18(c)	 Look at the structural formulae first: three structures correct scores 2 marks. two structures correct scores 1 If all three structures correct (any format), then all three classifications correct scores 1 Penalise displayed, partially displayed or structural formulae once only IGNORE Bond angles and names	Just the classifications	3

Total for Question 18 = 18 marks

Question Number	Acceptable Answers	Reject	Mark
19(a)(i)	Add hydrochloric acid / HCl(aq) / nitric acid / HNO_3(aq) ALLOW Just 'acid' only if a suitable acid is given in equation one Sulfuric acid / H_2SO_4((aq)) or HCl (1) IGNORE 'conc' Gas / carbon dioxide / CO_2 evolved turns lime water milky / cloudy / produces a white precipitate (1) MP2 is a stand alone mark but there must be some indication that a gas is being tested	Just 'acid' OR heating the carbonate	2

Question Number	Acceptable Answers	Reject	Mark
19(a)(ii)	ALLOW H_2CO_3(aq) for H_2O(l) + CO_2(g) $BaCO_3$(s) + 2HCl(aq) → $BaCl_2$(aq) + H_2O(l) + CO_2(g) OR $BaCO_3$(s) + 2HNO_3(aq) → $Ba(NO_3)_2$(aq) + H_2O(l) + CO_2(g) OR CO_3^{2-}(s) + 2H^+(aq) → H_2O(l) + CO_2(g) ALLOW $BaCO_3$(s) + H_2SO_4(aq) → $BaSO_4$(s/aq) + H_2O(l) + CO_2(g) OR $BaCO_3$(s) → BaO(s) + CO_2(g) (1) $Ca(OH)_2$(aq) + CO_2(g) → $CaCO_3$(s) + H_2O(l) (1) All state symbols in both equations correct (1) ALLOW State symbols mark if first equation not balanced but ALL species are correct. No TE on other equations		3

Question Number	Acceptable Answers	Reject	Mark
19(b)(i)	MP1 and MP2 Dip (clean) nichrome / platinum wire ALLOW loop / rod for wire OR Silica rod (1) in hydrochloric acid / HCl(aq) ALLOW any mention of HCl(aq) e.g. cleaning or mixing solid and acid HCl for HCl(aq) (1) ALLOW (for MP1 and MP2) (Wooden) splint (1) Soaked in distilled / deionised water (1) MP3 then dipped in solid and placed in (hot / roaring / blue-cone) (Bunsen) flame ALLOW On / over / under / above for 'in' (1) IGNORE inoculating / flame-test (wire)	Nickel / chrome / chromium spatula Other acids just 'water'	3

Question Number	Acceptable Answers	Reject	Mark
19(b)(ii)	A = Mg^{2+} (1) B = Ca^{2+} (1) Penalise omission of $^{2+}$ only once Correct ions with correct charge but the wrong way round scores 1 mark Correct ions with incorrect / no charge scores 1 IGNORE Names / compounds		2

Question Number	Acceptable Answers	Reject	Mark
19(b)*(iii)	Read the whole answer before awarding marks. If no mention of electrons only MP3 may be awarded. Electrons promoted to higher energy level (by thermal energy / heat from (Bunsen) flame) (1) (Promoted) electrons fall / drop / relax to lower energy level / orbital / shell / subshell OR Electrons return to ground state (1) Emitting radiation / light / photons (in the visible region) (1) IGNORE Colour	 Just 'electrons promoted/ excited' Just 'energy lost' Just 'energy given out	3

Question Number	Acceptable Answers	Reject	Mark
19(b)(iv)	Emitted radiation is not in the visible region (of the spectrum) ALLOW Emitted radiation is in IR / UV		1

Question Number	Acceptable Answers	Reject	Mark
19(c)	As group is descended... First mark (metal ion size) (Metal) ion radius increases / has more (electron) shells (but charge remains the same) OR Charge density of metal ion decreases ALLOW (Metal) atomic radius increases / has more (electron) shells (1) Second mark (polarizing species) Polarizing (ALLOW distorting) power of cation / metal ion decreases (1) Third mark (polarized species) Polarization / distortion of (electron cloud of) carbonate ion /anion decreases ALLOW C—O / C═O for carbonate ion (1) (so carbonate more stable to heat) ALLOW reverse argument for ascent of the group.	Just "metal" Just 'ion' Just 'ion or bond'	3

Total for Question 19 = 17 marks

Question Number	Acceptable Answers	Reject	Mark
20(a)	Methane undergoes more complete combustion / produces less CO OR Burning methane emits no (allow less) soot / carbon particles / particulates OR Burning methane emits no (allow less) sulfur / sulfur oxides OR Sulfur compounds are much more easily removed from methane OR Methane produces less CO_2 per unit of energy than coal ALLOW Any of these points reversed for coal IGNORE 'less CO_2 / greenhouse gases' 'carbon footprint' and 'emissions'		1

Question Number	Acceptable Answers	Reject	Mark
20(b)	Any mention of the ozone layer scores zero (A greenhouse gas) absorbs & re-emits / absorbs / traps / reflects IR (radiation) / heat (1) (re-radiating) from the Earth ALLOW Back to the Earth (1)	UV absorbed etc Absorbs from the sun	2

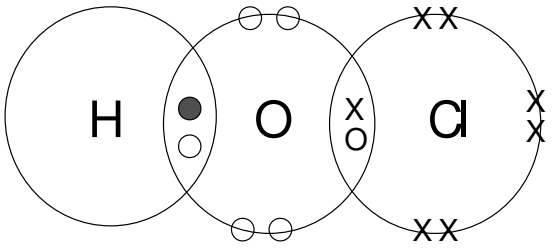
Question Number	Acceptable Answers	Reject	Mark
20(c)	Methane (molecule) absorbs IR radiation more effectively (because it has more IR active vibrations) OR Methane has a longer life in the atmosphere ALLOW Methane (molecule) absorbs more (IR) radiation OR Methane has more (vibrating polar) bonds OR Methane has 4 (polar) bonds (rather than 2)	C—H more polar than C=O	1

Total for Question 20 = 4 marks

Total for Section B = 39 marks

Section C

Question Number	Acceptable Answers	Reject	Mark
21(a)	Chlorine / Cl_2 / same species / element / atom is oxidized and reduced (in the same reaction) (1) Chlorine oxidized from 0 to +1 in HOCl /OCl^- /chlorate(I) (1) Chlorine reduced from 0 to −1 in HCl / Cl^- / chloride (1) If oxidized and /or reduced omitted or the wrong way round, max 1 (out of final 2 marks)		3

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	 Two bonding pairs (1) Five non-bonding electron pairs (1) IGNORE Lines representing bonds ALLOW Bonding pairs on the same horizontal line Different symbols for electrons max 1		2

Question Number	Acceptable Answers	Reject	Mark
21(b)*(ii)	No TE on incorrect structure in b(i) Penalise omission of "pairs" once only First mark Bond angle = 104.5° ALLOW 102°—106° (1) Second mark 2 bond pairs and 2 lone pairs (of electrons in valence shell of the oxygen atom) (1) Third & fourth marks (stand alone) (valence) electron pairs at minimum repulsion ALLOW maximum separation / distance apart (1) lone pair repulsion > bond pair repulsion (1) Fifth mark So tetrahedral bond angle reduced ALLOW 109° / 109.5° /109° 28' (angle) reduced (1)	'Bonds' for 'electron pairs'	5

Question Number	Acceptable Answers	Reject	Mark
21c(i)	Amount of $S_2O_3^{2-}$ = 9.65 x 0.00550 ÷ 1000 * (= 5.3075 x 10^{-5} mol) (1) Amount of Cl_2 (in 1 dm^3) = 0.5 x * = 0.5 x 9.65 x 0.00550 ÷1000 ** (= 2.65375 x 10^{-5} mol) (1) Mass of Cl_2 (in 1 dm^3) = 71 x 1000 x ** = 1.8842 (mg dm^{-3}) (1) (so within limits) ALLOW 1.8842×10^{-3} g dm^{-3} and so within limits An answer lower than 1 or higher than 2 mg dm^{-3} only scores a TE mark if there is a comment relating to the limits Correct answer with no working scores 1 Ignore SF except 1 SF Note If 0.5 omitted in MP2 and 35.5 used in MP3 then final answer is numerically correct; this scores only MP1	Incorrect units	3

Question Number	Acceptable Answers	Reject	Mark
21c(ii)	Concentration of chlorine might be different in different parts of the pool / at different times OR Sample size small in relation to pool volume IGNORE Just 'sample size is small' References to experimental uncertainty		1

Question Number	Acceptable Answers	Reject	Mark
21d(i)	$2HOCl \rightarrow 2HCl + O_2$ OR $HOCl \rightarrow HCl + \frac{1}{2}O_2$ OR Other multiples ALLOW HClO or $H^+ + ClO^-$ for HOCl		1

Question Number	Acceptable Answers	Reject	Mark
21d(ii)	London forces / dispersion forces / induced dipole- induced dipole attractions (ALLOW van der Waals / vdw forces) (1) Stronger because bromine (molecule) has more electrons / electron shells ALLOW greater surface area 'more' for 'stronger' (1)	dipole-dipole forces	2

Question Number	Acceptable Answers	Reject	Mark
21e(i)	All three marks are stand alone Lowering pH increases $[H^+]$ OR Increasing pH reduces $[H^+]$ ALLOW More/less H^+ IGNORE More acidic/alkaline (1) Lowering pH / increased $[H^+]$ shifts equilibrium to the left (so [HOBr] increases) (1) Increasing pH / reduced $[H^+]$ shifts equilibrium to the right (so $[OBr^-]$ increases) (1) Explanations must refer to equilibrium, but this may be implied	Just repeating information from the table	3

Question Number	Acceptable Answers	Reject	Mark
21e(ii)	Alkaline solutions are irritant (to the eyes) ALLOW caustic / corrosive saponifies / burns skin / chemical burns stings eyes IGNORE Harmful	toxic	1

Total for Question 21 = 21 marks
Total for Section C = 21 marks

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