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Mark Scheme (Results)

June 2011

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	Mark
1	C	**1**

Question Number	Correct Answer	Mark
2 (a)	B	**1**

Question Number	Correct Answer	Mark
2 (b)	C	**1**

Question Number	Correct Answer	Mark
2 (c)	D	**1**

Question Number	Correct Answer	Mark
3	C	**1**

Question Number	Correct Answer	Mark
4	B	**1**

Question Number	Correct Answer	Mark
5	B	**1**

Question Number	Correct Answer	Mark
6	A	**1**

Question Number	Correct Answer	Mark
7	D	**1**

Question Number	Correct Answer	Mark
8	A	**1**

Question Number	Correct Answer	Mark
9	A	**1**

Question Number	Correct Answer	Mark
10	D	**1**

Question Number	Correct Answer	Mark
11	C	**1**

Question Number	Correct Answer	Mark
12 (a)	B	**1**

Question Number	Correct Answer	Mark
12 (b)	C	**1**

Question Number	Correct Answer	Mark
12 (c)	D	**1**

Question Number	Correct Answer	Mark
13	A	**1**

Question Number	Correct Answer	Mark
14	D	**1**

Question Number	Correct Answer	Mark
15	B	**1**

Question Number	Correct Answer	Mark
16	C	**1**

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
17 (a)	**Pale/ light and green/ yellow** Allow (virtually) colourless	clear yellow green any other colour	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (b)(i)	Red/brown (solution) Allow yellow Ignore (From….) to….	Purple (or in combination with red or brown) Pale yellow Orange (or in combination with red or brown) Reject any other colours alone or in combination Grey/black (or any other colour alone or in combination) solid	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (b)(ii)	$Cl_2(aq) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(aq)/(s)$ Entities **(1)** Balancing **and** all four state symbols Dependent on correct entities **(1)** $Cl_2(aq) + 2KI(aq) \rightarrow 2KCl(aq) + I_2(aq)/(s)$ 1 max $K^+(aq)$ on both sides of otherwise correct equation 1 max		**2**

Question Number	Acceptable Answers	Reject	Mark
17 (c)(i)	Starch **(1)** Blue/black to colourless Dependent on starch indicator **(1)** Accept: no indicator needed **(1)** Yellow to colourless **(1)** Blank for indicator and yellow to colourless 1max	Any other indicator e.g. methyl orange/ phenolphthalein = 0/2 Colourless to blue/black Blue/black to clear Any mention of purple	**2**

Question Number	Acceptable Answers	Reject	Mark
17 (c)(ii)	(ii) – (vi) General comments: Allow correct answers with no working in all parts N.B. Mark each part to mark scheme answer first then allow TE from earlier parts. Minimum correct to 2SF. Penalise SF for 1SF once only. But incorrect rounding e.g. 4.525 to 4.52 is penalised once separately as well. Penalise wrong units once only as well. (Mean titre = 9.05) $\frac{9.05 \times 0.01}{1000}$ $= 9.05 \times 10^{-5}$ /0.0000905(mol) Allow 9.1×10^{-5}/0.000091(mol)	$9.(0) \times 10^{-5}$ / 0.00009(0)	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (c)(iii)	$(I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow)$ $\mathbf{2I^-}(aq) + \mathbf{S_4O_6^{2-}}(aq)$ **(1) (1)** Marks stand alone for entities with balancing Either of these on their own scores 1 mark regardless of anything else that is written Multiples/fractions of equation allowed Ignore state symbols even if incorrect		**2**

Question Number	Acceptable Answers	Reject	Mark
17 (c)(iv)	$\frac{9.05 \times 10^{-5}}{2}$ $= 4.525 \times 10^{-5}$ /0.00004525(mol) Allow 4.53×10^{-5} /0.0000453 etc Allow TE $\frac{\text{ans (ii)}}{2}$ Accept TE from (iii) if you see it		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (c)(v)	4.525×10^{-5} /0.00004525 (mol) Allow TE = ans (iv) [Allow 'ans (iv)' with no numbers for this part only]		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (c)(vi)	$4.525 \times 10^{-5} \times \frac{1000}{10}$ = 4.525/4.53 x 10^{-3} /0.004525/0.00453 (mol dm^{-3}) Accept TE ans (v) x 100 [a calculated number must be given]		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (d)(i)	Lilac Allow (light) purple or mauve	Violet Reject any other colours alone or in combination	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (d)(ii)	$2K + Cl_2 \rightarrow 2KCl$ Accept multiples/fractions Ignore state symbols even if incorrect Ignore correct charges on ions in KCl	K_2 and/or KCl_2 Charges on reactants K and/or Cl_2	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (e)(i)	Hydrogen chloride This may be accompanied by HCl	Hydrochloric acid HCl /HCl(g)/HCl (gas) alone SO_2 H_2S Anything else	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (e)(ii)	Dissolves in moisture/water/water vapour (in the air) **Or** reacts with moisture/water/water vapour (in the air)	HCl condenses	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (e)(iii)	NH_4Cl / Ammonium chloride/ $ClNH_4$ $NH_4^+Cl^-$ / $H_4N^+Cl^-$/ $Cl^-NH_4^+$ Ignore any states even if incorrect	Ammonia chloride / NH_3Cl	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (f)(i)	Any one of: Phosphorus(V) chloride/pentachloride Phosphorus(III) chloride/trichloride Allow (III/V) anywhere **Conc**entrated hydrochloric acid Hydrogen chloride (gas) Sodium/potassium chloride and **conc**entrated sulfuric acid Thionyl chloride Allow correct formula(e) for all above But note: **conc** HCl /**conc** H_2SO_4	Phosphorus chloride Hydrochloric acid/HCl/ HCl(aq) Chlorine	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (f)(ii)	Be generous here Horizontal test tube with ceramic fibre/ any sort of wool except iron **(1)** soaked in 2-chlorobutane and (alcoholic) potassium hydroxide/reactants/ reagents/ chemicals/reaction mixture… …with **heat** (or any diagram of a heat source or the word heat) **(1)** OR Round bottom/pear shaped flask/sloping test/boiling tube and **heat** (or any diagram of a heat source or the word heat) **(1)** containing 2-chlorobutane and (alcoholic) potassium hydroxide/reactants/ reagents/ chemicals/reaction mixture **(1)** Ignore: any use of aluminium oxide/pumice reflux/distillation set up Gas collection over water **(1)** Ignore Bunsen valves Allow: Collection in a gas syringe Note: This does not constitute a sealed apparatus	Sealed apparatus but ignore inadvertent closures owing to poor cross-sectional drawings (-1) Poor diagram e.g. clear air gaps at intermediate joints in the apparatus(-1) Solution/substances alone An arrow on its own Conical/flat bottomed flask N.B. contradiction between drawing and any label Solution/substances alone A poor diagram mark (which can be the second) should be deducted for the delivery tube through the side of trough and/or the delivery tube missing the collection tube.	**3**

Question Number	Acceptable Answers	Reject	Mark
18 (a)(i)	H H .x .x xx H.xC.xC.xSx.H .x .x xx H H **All** Bonding electrons **(1)** Ignore any circles/bonds with electrons Two lone pairs on sulfur Dependent on eight electrons around sulfur **(1)** Accept all dots/crosses Fully correct methanethiol 1max	missing Hs/Cs (-1)	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (a)(ii)	104.5 (^{o}) (accept 91 to 105)**(1)** (Four pairs/two bonding pairs and two non-bonding pairs of electrons in) **minimum repulsion/ maximum separation/ as far apart as possible** (tetrahedral arrangement) Ignore the number of pairs of electrons **(1)** And **lone/ non bonding pair(s)** of electrons **repel more** (than bond pairs/CH bonds) **(1)** Mark independently	atoms… Linear shape (-1) …repel any sort of atoms	**3**

Question Number	Acceptable Answers	Reject	Mark
18 (b)(i)	**Two** pairs of electrons/**two** bonds (around the H atom) OR Can be shown on a diagram either with electrons or bonds (in approximate straight line) around the hydrogen **(1)** (Repel to) maximum separation/minimum repulsion/as far apart as possible **(1)** Dependent on first mark except: Allow: It has a **linear** shape due to maximum separation/minimum repulsion 1 max	Linear shape on its own	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (b)(ii)	Sulfur is less electronegative (than oxygen)/not electronegative enough OR oxygen is more electronegative (than sulfur) / electronegative enough OR Hydrogen bonds can only occur between H and either N, O, or F **due to the large difference in electronegativity**	Bigger/higher rmm/ atom/molecule alone Hydrogen not bonded to N, O, or F alone	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (c)(i)	Temporary asymmetrical distribution/ random arrangement of electrons/ charge (density) Ignore references to atoms/molecules OR instantaneous/temporary dipole **(1)** (these produce) induced dipoles OR description of induction **(1)** Mark independently Ignore references to atoms/molecules	Any mention of permanent dipoles = 0/2 d+ and d- /∂+ and ∂- unless clearly temporary	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (c)(ii)	Ethanethiol/sulfur has more electrons (so forces are stronger) Allow sulfur has an extra shell **of electrons** OR ethanol/oxygen has fewer/less electrons (so forces are weaker) Allow oxygen has one fewer shell **of electrons**	Larger charge cloud/ larger electron cloud/ more outer electrons on their own Any reference to size/radius/rmm unless with correct answer	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (d)(i)	Any one from: Bubbles (of gas) /fizzing /effervescence Sodium disappears/dissolves/gets smaller White solid forms Multiple answers: number correct minus number wrong to give a maximum of 1 and a minimum of 0 Ignore: sodium floats or sinks and/or heat given out and/or hydrogen produced	Sodium rushes about (i.e. any confusion with reaction of sodium with water) Flames Steam	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (d)(ii)	$Na + CH_3CH_2SH \rightarrow CH_3CH_2SNa + ½H_2$ Accept multiples Ignore charges on sodium salt/state symbols even if incorrect	H for hydrogen CH_3CH_2NaS	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (e)(i)	$C_2H_5Br + KOH \rightarrow C_2H_5OH + KBr / K^+ + Br^-$ Accept ionic equation $C_2H_5Br + OH^- \rightarrow C_2H_5OH + Br^-$ Allow molecular formula of alcohol, C_2H_6O		**1**

Question Number	Acceptable Answers	Reject	Mark
18 (e)(ii)	Type – substitution **(1)** Mechanism – Nucleophilic **(1)** Accept words in either order. Both words may be given on either line. <u>N.B. This is the **only** way to score 2 marks!</u>		**2**

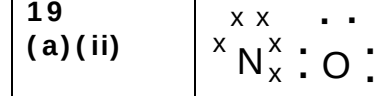
Question Number	Acceptable Answers	Reject	Mark
18 (e)(iii)	KSH /NaSH Allow KHS/NaHS or H_2S Ignore state symbols		**1**

Question Number	Acceptable Answers	Reject	Mark
18 (f)	Sulfur dioxide/SO_2 **(1)** Causes acid rain **(1)** Allow effects of acid rain e.g. acid lakes/lake pollution/ crop or forest damage/**limestone** building damage/**named metal** which corrodes. [It is quite possible candidates will give details of oxidation of sulfur dioxide to sulfur trioxide and formation of sulfuric acid. Ignore any of this additional information.] Allow triggers asthma Ignore any reference to greenhouse gas/ global warming/any reference to sea pollution or sea creatures Second mark dependent on first mark except allow: If SO_2 not mentioned then, SO_3/H_2SO_4 causes acid rain for 1 mark	SO_3 CO_2 Attacks ozone layer CO_2 causes acid rain	**2**

TOTAL FOR SECTION B = 40 MARKS

Section C

Question Number	Acceptable Answers	Reject	Mark
19 (a)(i)	An atom/ molecule (or ion)/species/entity with an unpaired electron Ignore any references to homolytic bond fission but penalise a reference to heterolytic bond fission	Lone/single/free electron with unpaired electron**s** A free radical is an unpaired electron	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (a)(ii)	 Double bond **(1)** Other electrons correct Dependent on double bond **(1)** Allow: all dots or all crosses or any combination	N single bond O Reject unpaired electron on oxygen	**2**

Question Number	Acceptable Answers	Reject	Mark
19 (b)(i)	Wherever it appears in the answer: Ag/silver (oxidized) 0 to +1/1+ **(1)** Wherever it appears in the answer: N/Nitrogen = +5/5+ **(1)** (Element reduced) **N/ nitrogen** … to +2/2+ **(1)** N.B. Some candidates give …+2/2+ and +5/5+ which is correct for both nitrogen products Only penalise no positive charges once		**3**

Question Number	Acceptable Answers	Reject	Mark
*** 19 (b)(ii)**	$3Ag(s) + 4HNO_3(aq) \rightarrow NO(g) + 3AgNO_3(aq) + 2H_2O(l)$ 3Ag reacting to form NO and $3AgNO_3$ **(1)** $4HNO_3$ and $2H_2O$ **(1)** mark independently of (b)(i) No TE from (b)(i)		**2**

Question Number	Acceptable Answers	Reject	Mark
19 (c)(i)	The reaction is **endothermic** (so goes to remove heat/lower the temperature) Allow **ΔH is positive** (so goes to remove heat/lower the temperature)	Reaction/equilibrium moves to the right/to oppose change without any other statement	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (c)(ii)	The yield is not changed OR No change OR no effect on the equilibrium **(1)** as there is no change in the number of (moles of) (gaseous) **molecules** OR as there is no change in the number of (gaseous) moles/particles **(1)** Allow: cylinder surface acts as catalyst **(1)** And all sites are filled so pressure has no affect **(1)** Second mark dependent on first in both cases Ignore any comment on rate whether correct or not	Reference to atoms or ions instead of molecules	**2**

Question Number	Acceptable Answers	Reject	Mark
19 (c)(iii)	**Rate increases because** (increase in pressure) means more particles per unit volume/less space for molecules/molecules closer together/greater or increased concentration **(1)** Comment: A correct statement of why the rate increases is needed with **rate increases** (somewhere in the answer) for the first mark which increases the frequency / increases the number of collisions/more chance of (successful) collisions (between molecules) **(1)** Ignore any references to (activation/kinetic) energy Mark independently	more particles per unit area Reference to atoms or ions instead of molecules	**2**

Question Number	Acceptable Answers	Reject	Mark
***19 (d)(i)**	Jet aeroplanes fly (much) close(r)/near(er) to the ozone (layer)/ stratosphere (so more NO to deplete ozone layer) **(1)** ALLOW: Jet aeroplanes fly in the ozone (layer)/ stratosphere Some NO from cars reacts (e.g. with O_2 to give NO_2) OR NO from planes does not react before it can react with the ozone **(1)** Mark independently	Anything else e.g. aeroplanes fly in the ionosphere NO absorbed by plants NO from cars dissociates/ decomposes/break down NO from planes does not dissociate/decompose/break down NO from cars takes a long time to reach the ozone layer NO dissolves	**2**

Question Number	Acceptable Answers	Reject	Mark
19 (d)(ii)	Comment: Please underline Key Points with highlighter, or annotate with tick at Key Point, or annotate with Key Point number from mark scheme wherever mark awarded. This ensures that it is easy to count up marks for this part. **KP1** $NO(\bullet) + O_3 \rightarrow (\bullet)NO_2 + O_2$ **(1)** Comment: Dots are not required for KP1 **KP2** $\bullet NO_2 + O_3 \rightarrow NO\bullet + 2O_2$ **(1)** Comment: Dots can be on either side of both free radicals ALLOW for KP2: $O_3 \rightarrow O\bullet + O_2$ $\bullet NO_2 + O\bullet \rightarrow NO\bullet + O_2$ **N.B. Both** equations required here The overall equation is: **KP3** $2O_3 \rightarrow 3O_2$ **(1)** ALLOW: equilibrium arrow This mark is independent of KP1 and KP2 **KP4** NO/the free radical (Allow Cl•) is regenerated/a catalyst or wtte **(1)** **KP5** and one molecule can break down large numbers of ozone molecules OR NO (Allow Cl•) continues to react (with ozone)/reaction is continuous OR Mention of chain reaction **(1)** Ignore any reference to global warming **as an additional problem** KP4 and 5 marks are independent	Overall equation with nothing cancelled If Cl^- is referred to as the radical then neither KP4 nor KP5 can be gained If the candidate makes clear that any of these **processes lead to** global warming loses KP4 or 5 but not both.	**5**

TOTAL FOR SECTION C = 20 MARKS

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