Mark Scheme (Results)

January 2013

GCE Chemistry (6CH01) Paper 01
The 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	Mark
1	D	**1**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Question Number	Correct Answer	Mark
16(a)	D	**1**
(b)	D	**1**
(c)	C	**1**
(d)	B	**1**
(e)	B	**1**

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
17 (a) (i)	$2Al(s) + 2OH^{-}(aq) + 2H_2O(l) \rightarrow 2AlO_2^{-}(aq) + 3H_2(g)$	$20_2^{2-}(aq)$	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(ii)	$\left(\frac{2 \times 10}{1000} = 0.02 / 2 \times 10^{-2}\right)$ Ignore trailing zeroes		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(iii)	$0.02 / 2 \times 10^{-2}$ <u>Accept TE answer to (ii)</u>		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(iv)	$0.02 \times 27.0 = 0.54 / 5.4 \times 10^{-1}$ (g) TE answer to (iii) OR (ii) x 27.0 Ignore sf except 1	Other unit	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(v)	$(1.1 \times 0.54) = 0.59(4) / 5.9(4) \times 10^{-1}$(g) TE answer to (iv) x 1.1 Ignore sf except 1 Only penalise sf once		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(vi)	**Potassium hydroxide / KOH** (solution) is corrosive / burns / caustic **OR** **KOH** damages / harms / is harmful to / dissolves / reacts with **skin / eye(s)** **(1)** **OR** **KOH** in **eye(s)** **(1)** **Ignore** Harmful, irritant, highly reactive alone **Hydrogen / H_2** is flammable / explodes / explosive **(1)** Allow mention of both potassium hydroxide and hydrogen alone scores **(1)** Allow Al foil can cut your skin **(1)** Correct answer with additional incorrect chemistry e.g. KOH is oxidising so corrosive scores **(0)**	Toxic, carcinogenic, alone or in combination with correct answer Burns alone Additional chemicals	**2**

Question Number	Acceptable Answers	Reject	Mark
17 (b)(i)	$KAlO_2(aq) + \mathbf{2}H_2SO_4(aq) \rightarrow KAl(SO_4)_2(aq) + \mathbf{2}H_2O(l)$ Allow multiples		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (b)(ii)	$\frac{2 \times 1000 \times 0.02}{1} = 40\ (cm^3)$ Allow 0.04(0) **dm^3** TE answer to (a)(ii) x 2000 and TE from (b)(i)		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (b)(iii)	Litmus (paper / solution) **(1)** Red / pink (in acid) **(1)** OR any other named acid-base indicator including universal indicator **(1)** with a correct acidic colour **(1)** NB phenolphthalein must be spelt correctly to score **(1)** and no mark for colour Notice that other indicators only require recognisable spellings Red litmus turns blue scores for the indicator **(1)** OR pH meter / universal indicator **(1)** with value < 7 **(1)** NB measure pH alone (0) pH < 7 **(1)** OR add a (metal) carbonate / suitable metal eg Mg **(1)** bubbles / fizzing **(1)** Calculation of amounts / moles of **both** reactants (1 maximum)		**2**

Question Number	Acceptable Answers	Reject	Mark
17 (b)(iv)	**Each point must be made in full** **The second and final scoring points, which are asterisked, can only be gained through these statements. Two further marks can be scored for any two of the other four points.** 1 Filter (to remove any aluminium / impurities) **(1)** NB This mark can only be awarded if it is the first action **and** the mixture is subsequently heated. 2 *Boil / heat / evaporate to reduce the volume of water **(1)** NB boil / heat to remove water only gets the mark if it is clear, subsequently, that some solution is left 3 Cool / set aside / leave to allow crystals to form **(1)** 4 Filter OR pick out / remove / take out crystals (to separate) **(1)** 5 Wash with a **little / cold** water **(1)** 6 *Place between filter papers / dab with paper towel / use dessicator (to dry) **(1)**	Leave in the sun If boiled to dry stop marking here Heat in oven	**4**

Question Number	Acceptable Answers	Reject	Mark
17 (b)(v)	White / colourless Ignore clear / transparent / cloudy / opaque e.g. accept clear and colourless	Any other colours with or without white	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (b)(vi)	Cr^{3+}/ Fe^{3+}/ Sc^{3+} / Ga^{3+} Accept any feasible triply positive metal ion Allow B^{3+} Allow any name or symbol for a Group 3 element Allow named existing transition metal ions with (III) after the name (if they exist) Fully correct formula for an alum or intermediate starting entity Eg $KGa(SO_4)_2$ / $KGaO_2$	Al^{3+} and anything else Group 3 element with incorrect charge	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (a)	$[:Li]^+$ (1) $\left[\begin{array}{c} xx \\ xx\ I\ xx \\ xx \end{array}\right]^-$ (1) Accept all or mixture of dots and crosses **Check inner electrons present on lithium** If no element symbols but fully correct with Li first give **1 max** If no / incorrect charge(s) if the electrons are correct **1 max** If arrow drawn from third / outer shell electron on lithium to join electrons in iodine / iodide with correct charges scores **1 max** Brackets are not essential		2

Question Number	Acceptable Answers	Reject	Mark
18 (b)	Li(s) **and** Li^+(g) **and** I^-(g) **(1)** ½I_2(s) **and** I(g) **(1)** (ΔH_{at})**[**½I_2(s)**]** **(1)** Notice the square brackets are essential for this mark If wrong state for iodine element ie if ½I_2(g/l) and consistent (ΔH_{at})[½I_2(g/l)] allow third mark If I(s) given for element and (ΔH_{at}) [I(s)] allow third mark If wrong state with monatomic iodine both the last two marks lost If Li^+(g) + e appears ignore electron		3

Question Number	Acceptable Answers	Reject	Mark
18 (c)	**First mark for one of:** $-270 = + 159 + 107 + 520 +$ electron affinity $- 759$ Or Electron affinity = $-270 - (159 + 520 + 107 - 759)$ **(1)** OR Electron affinity = $-270 - 159 - 520 - 107 + 759$ **(1)** **Second mark for:** (Electron affinity =) -297 (kJ mol^{-1}) **(1)** -297 (kJ mol^{-1}) alone scores **(2)** NB providing method is recognisable with one transcription error eg 795 for 759 and the final answer is consistent **1 max** NB (+) 297 (kJ mol^{-1}) **1 max**	Wrong unit e.g. J	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (d)	(Experimental lattice energy is) more negative / exothermic **(1)** OR Theoretical lattice energy is less negative / exothermic **(1)** OR Recognition that more energy **released** **(1)** Irrespective of first answer then, any two from: Due to a degree of covalency **(1)** Deviation from pure ionic model (in experimental value) OR The theoretical model is pure ionic bonding **(1)** **Polarization / distortion** of the iod**ide** / negative ions (by the lithium ion). Can be shown by diagram **(1)** Iodine/ I / I_2 ion is not acceptable but iodine / I **anion** is allowed Note I_2 anion is not allowed	Greater / less Increase / decrease alone	**3**

Question Number	Acceptable Answers	Reject	Mark
18 (e)	Electron affinities become less negative / less exothermic / more positive (going down Group 7) **(1)** As (added) **electron** further from the nucleus OR **More** shielding / shielded (from the nucleus) **(1)** Second mark stands alone Ignore larger (ionic) radius / atom / ion / charge density	Greater / less / Increase / decrease alone Any indication of ionization/ removing an electron	**2**

Question Number	Acceptable Answers	Reject	Mark
19 (a)	All have the same number of electrons / all have one (s) electron / same electron configuration **(1)** All have the same number of protons / all have one proton **(1)** The first has no neutrons, the second one neutron and the third two neutrons Allow deuterium has one more neutron, tritium two more neutrons **(1)** Ignore references to same atomic number and different mass numbers	All have one p electron Different number of neutrons alone	**3**

Question Number	Acceptable Answers	Reject	Mark
19 (b)	($^{14}_{7}N$ + $^{1}_{0}n$ → $^{3}_{1}H$ +) $^{12}_{6}C$ Numbers can be on either side or both sides		**1**

Question Number	Acceptable Answers	Reject	Mark
19 (c)(i)	**Molar mass / M(r) / 3+2 / 2+3** = 5 (g mol^{-1}) (1) Number of moles = 4/5 = 0.8 **(1)** O.8 with correct working, with wrong working, or with no working **(2)** Allow internal TE if Molar mass clearly indicated and incorrect eg Molar mass / M(r) = 6 (g mol^{-1}) **(0)** Number of moles = 4/6 = 0.67 **(1)**	Penalise incorrect units	**2**

Question Number	Acceptable Answers	Reject	Mark
19 (c)(ii)	24 000 x 0.8 = 19 200 (cm^3) Allow 19.2 **dm^3** Allow TE from (c)(i)	Incorrect units	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (d)	$\frac{1.0078 \times 99.9850 + 2.0141 \times 0.0150}{100}$ OR $\frac{1.0078 \times 99.9850 + 2.0141 \times 0.0150}{99.9850 + 0.0150}$ **(1)** Notice this working must be shown in full to score first mark. (= 1.007951) = 1.0080 **(1)** 1.008 max 1 with or without working Correct answer no working **(2)** Only give second mark for correct answer to 4 decimal places Ignore g mol^{-1}	Incorrect units e.g. g	**2**

Question Number	Acceptable Answers	Reject	Mark
19 (e)(i)	Single arrow **upwards** from lowest line to infinity line (allow above or very close below) Allow double headed arrow	More than one line	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (e)(ii)	Hydrogen $1s^1$ **and** Sodium $1s^2\ 2s^2\ 2p^6\ 3s^1$ **(1)** Electron numbers may be on lines or subscript. Both have one (s) electron in the **outer** shell / orbital / sub shell OR same number of electrons / same electron(ic) configuration in **outer** shell / orbital / sub shell OR Both have an/one unpaired electron in their **outer** / **last** shell / orbital / sub shell **(1)** Second mark depends on one outer shell s electron shown for each electronic configuration	$1s^2\ 2s^1$ half filled s outer shell same electron(ic) configuration alone	**2**

Question Number	Acceptable Answers	Reject	Mark
19 (f)	Helium **(1)** Any two from the following points: Electron removed is closest / close to the nucleus **(1)** Little shielding, allow no shielding **(1)** More protons / higher nuclear charge than hydrogen. Allow higher effective nuclear charge **(1)** **NB** second and third marks can be gained if **hydrogen** is given: Electron removed is close / closest to the nucleus **(1)** No shielding **(1)**	Any other elements	3

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>20(a)</td><td>$C_2H_6(g) + 3½O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

Formulae and states (1)

Balancing of correct entities (1)</td><td>Multiples</td><td>2</td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>20(b)</td><td>Notice the first mark is for the equation and there are 3 separate additional marks for the calculation

H H H H
| | | |
H-C-C-H + Cl-Cl → H-C-C-Cl + H-Cl
| | | |
H H H H (1)

Check all bonds displayed especially Cl-Cl and H-Cl

Calculation marks:

+413 + 243 (1) (−)(346 + 432) (1)

OR 656 (1) (−) 778 (1)

= −122 (kJ mol^{-1}) (1)

Fully correct answer to calculation with no working (3)

Extra 5x413 and 347 may be included on both sides, giving 3068 and (-)3190

Allow other same values(s) missing from both sides

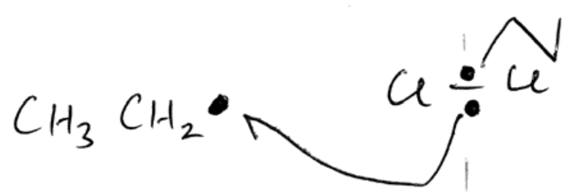
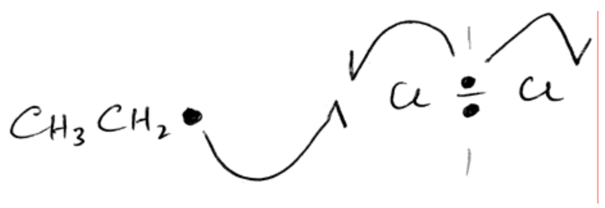
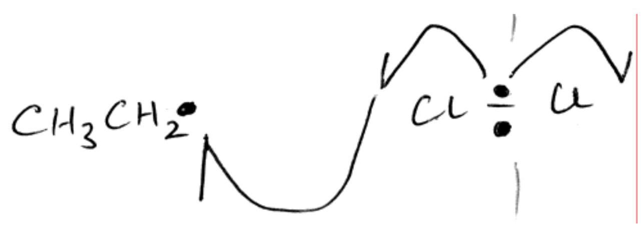
Bonds breaking (1)

Bonds making (1)

[Bonds breaking - bonds making] to give correct answer with sign (1)</td><td>Incorrect / no sign and / or incorrect units

Incorrect units loses this mark</td><td>4</td></tr>
</table>

Question Number	Acceptable Answers	Reject	Mark
20 (c)(i)	Initiation **(1)** Allow homolysis / atomization / homolytic (fission) Ignore any reference to free radical substitution UV / (sun)light **(1)** Ignore reference to high temperature	Free radical substitution alone Photolysis	**2**

Question Number	Acceptable Answers	Reject	Mark
20 (c)(ii)	$CH_3CH_2\bullet$ + Cl-Cl $\rightarrow$ CH_3CH_2Cl + $Cl\bullet$ OR $CH_3CH_2\bullet$ + Cl-Cl $\rightarrow$ C_2H_5Cl + $Cl\bullet$ Both products correct including dot (1) Two half headed arrows showing homolytic breaking of Cl-Cl bond **(1)** Half headed arrow from radical to pair with a Cl arrow OR One arrow from chlorine bond clearly to ethyl radical **(1)** Arrows must be single-headed     The two dots in the covalent bond do not have to be shown		**3**

Question Number	Acceptable Answers	Reject	Mark
20 (c)(iii)	$Cl\bullet + Cl\bullet \rightarrow Cl_2$ **(1)** $\bullet CH_2CH_3 + \bullet CH_2CH_3 \rightarrow CH_3CH_2CH_2CH_3$ / C_4H_{10} **(1)** $\bullet CH_2CH_3 + Cl\bullet \rightarrow CH_3CH_2Cl$ **(1)** Penalise missing dots once Allow $\bullet C_2H_5$ for $\bullet CH_2CH_3$ Di and tri substitution steps	C_4H_{12} $CH_3CH_2CH_3CH_2$	**2**

Question Number	Acceptable Answers	Reject	Mark
20 (d)	$C_2H_6 \rightarrow C_2H_4 + H_2$ Allow $\mathbf{2}C_2H_6 \rightarrow C_2H_4 + \mathbf{2}CH_4$		**1**

Question Number	Acceptable Answers	Reject	Mark
20 (e)	Any two from: (It) produces (more) petrol / gasoline / diesel / jet fuel / LPG / liquid petroleum gas / fuel **(1)** Short chain alkanes / lighter fractions are more useful products **(1)** Demand is greater for shorter chain alkanes / lighter fractions / smaller molecules OR converts surplus of low demand fractions **(1)** It produces ethane / short chain alkenes for making poly(ethene) / ethane-1,2-diol / ethanol / plastics / polymers **(1)** Smaller alkanes give less pollution/burn more efficiently **(1)** Recycles waste products **(1)** As a source of hydrogen **(1)** **NB** examiners need to look carefully at the vowel in the middle of alk**a**ne / alk**e**ne / eth**a**ne / eth**e**ne if not clear do not give BOD	Points based on atom economy / renewable fuels alone Easier to transport / store Short chain alkenes / ethene more useful alone Recycles alone	2

TOTAL FOR SECTION B = 60

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