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Mark Scheme (Results)

Summer 2013

GCE Chemistry 6CH01/01R
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

Question Number	Correct Answer	Mark
1	C	1

Question Number	Correct Answer	Mark
2	B	1

Question Number	Correct Answer	Mark
3	B	1

Question Number	Correct Answer	Mark
4	D	1

Question Number	Correct Answer	Mark
5	D	1

Question Number	Correct Answer	Mark
6	A	1

Question Number	Correct Answer	Mark
7	D	1

Question Number	Correct Answer	Mark
8	B	1

Question Number	Correct Answer	Mark
9	C	1

Question Number	Correct Answer	Mark
10	A	1

Question Number	Correct Answer	Mark
11	D	1

Question Number	Correct Answer	Mark
12	C	1

Question Number	Correct Answer	Mark
13	C	1

Question Number	Correct Answer	Mark
14	B	1

Question Number	Correct Answer	Mark
15	D	1

Question Number	Correct Answer	Mark
16	C	1

Question Number	Correct Answer	Mark
17	B	1

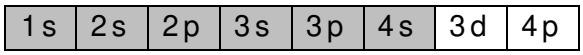
Question Number	Correct Answer	Mark
18	A	1

Question Number	Correct Answer	Mark
19	B	1

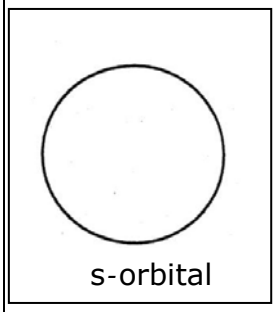
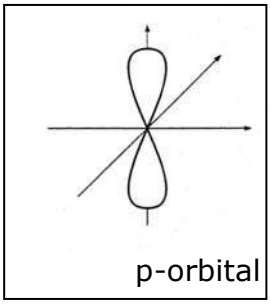
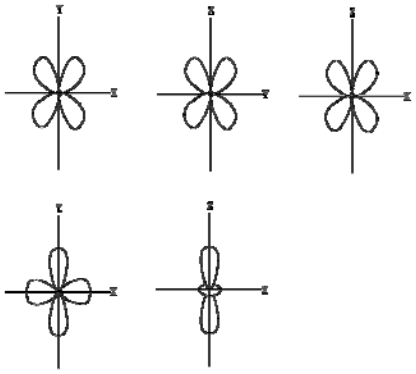
Question Number	Correct Answer	Mark
20	D	1

Total for Section A = 20 Marks

Section B

Question Number	Acceptable Answers	Reject	Mark
21 (a)	 3d 4p (2) ALLOW 4p 3d scores 1 out of 2 4p 5s scores 1 out of 2 ALLOW use of capital letters e.g. "3D and/or 4P"	'4p 4d' or '4d 4p' gets 0	2

Question Number	Acceptable Answers	Reject	Mark
21 (b)(i)	A region / space / volume (around the nucleus / atom) where there is a high probability / chance / likelihood / of finding an electron ALLOW 'area' / 'sub-shell' as alternative for region OR A region where an electron is likely to be found	Just 'the path an electron takes orbiting around a nucleus' Just 'Position of electrons in an atom'	1

Question Number	Acceptable Answers	Reject	Mark
21 (b)(ii)	 s-orbital (1)  p-orbital (1)	For s-orbital do not allow ellipse for first mark pi bond d-orbitals shown below 	2

Question Number	Acceptable Answers	Reject	Mark
21 (c)	11 / eleven ALLOW $2p^6 3p^5$	 $1s^2 2s^2 2p^6 3s^2 3p^5$	1

Question Number	Acceptable Answers	Reject	Mark
21 (d)	18 / eighteen	$1s^2 2s^2 2p^6 3s^2 3p^6$	1

Question Number	Acceptable Answers	Reject	Mark
* 21 (e)	Enthalpy / energy / heat / heat energy per mole required/ needed OR Enthalpy / energy / heat / heat energy change per mole (1) to remove one / an electron (1) from gaseous atom(s) (1) "Energy required to remove one mole of electrons from one mole of gaseous atoms" scores all three marks NOTE: The equation: $X(g) \rightarrow X^{+}(g) + e^{-}$ scores the last two marks NOTE: An incorrect equation given with a correct definition in words scores 2 out of 3 marks	"Energy given out …" for first mark	3

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th></th><th>Mark</th></tr>
<tr><td>21 (f)</td><td>
<table>
<tr><td>Ionization energy / kJ mol^{-1}</td><td>496</td><td>4563</td><td>6913</td><td>9544</td><td>13352</td><td>16611</td><td>20115</td><td>25491</td><td>28934</td><td>141367</td><td>159079</td></tr>
<tr><td>Ionization number</td><td>1st</td><td>2nd</td><td>3rd</td><td>4th</td><td>5th</td><td>6th</td><td>7th</td><td>8th</td><td>9th</td><td>10th</td><td>11th</td></tr>
<tr><td></td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
</table>

All five correct = 2 marks

Four/three correct = 1 mark

Two/one/none correct = 0 marks
</td><td></td><td>2</td></tr>
</table>

Total for Question 21 = 12 marks

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Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	The mark is for the idea of impact by high energy electrons Any ONE of: High-energy electrons Bombard with electrons Fast electrons (fired at sample) Accelerated electrons (fired at sample) (High-energy) electrons fired (at sample) (Sample) blasted with electrons Electron gun ALLOW "beam of electrons" IGNORE any comments about ionization of the sample whether correct or incorrect IGNORE descriptions of vaporisation	High-density electrons	1

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	Electric field / (negatively) charged plates ALLOW voltage plates electrostatic field electrical field pushed by positively (charged) plate/ anode	Positively charged plates alone / electronic field / electric current / electricity / electrical charge / (electro) magnetic field / electric coil	1

Question Number	Acceptable Answers	Reject	Mark
22 (a)(iii)	Magnetic field /magnet / electromagnet /magnetic plates / electromagnetic field	Negative magnetic field/ negatively charged magnet	1

Question Number	Acceptable Answers	Reject	Mark
22(b)	(194 x 32.8) + (195 x 30.6) + (196 x 25.4) + (198 x 11.2)) ÷ 100 (1) = 195.262 = 195.3 (1 d.p.) (1) Method (1) Answer must be to 1 d.p. IGNORE g , g mol^{-1} or amu but other wrong units lose a mark Correct answer with no working (2) ALLOW TE for second mark if 1 numerical slip in transferring data from the table and answer to 1 d.p		2

Question Number	Acceptable Answers	Reject	Mark
22(c)	d(-block) ALLOW D(-block) IGNORE Transition element(s) / transition metal(s)		1

Question Number	Acceptable Answers	Reject	Mark
22(d)(i)	(Na): ✓ and ✓ (1) (Na_2O): x and ✓ (1)		2

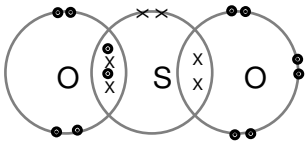
Question Number	Acceptable Answers	Reject	Mark
* 22 (d) (ii)	Na: conducts when both solid and molten due to (delocalized)free / mobile electrons (1) Na_2O: does not conduct when solid as no mobile ions / ions unable to move / ions in fixed position (1) Na_2O: conducts when molten as has mobile ions (1)	Ions with reference to either form of sodium metal electrons electrons	3

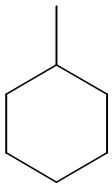
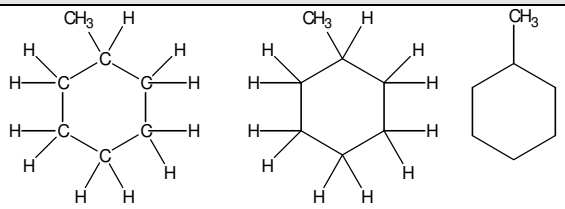
Total for Question 22 = 11 marks

Question Number	Acceptable Answers	Reject	Mark
23(a)	C_nH_{2n+2} IGNORE 'where n=1, 2, 3 etc' or 'where n is greater than 1'		1

Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	$C_{10}H_{22} + 10½O_2 \rightarrow 10CO + 11H_2O$ ALLOW 21 / 2 O_2 ALLOW any correct multiples IGNORE state symbols, even if incorrect	21 [O]	1

Question Number	Acceptable Answers	Reject	Mark
23(b)(ii)	Any statement that makes it clear there is not enough air or oxygen e.g. Limited supply of air / limited supply of oxygen / not enough air / not enough oxygen / lack of oxygen / little amount of oxygen/ small amount of oxygen IGNORE "it is not completely oxidized"		1

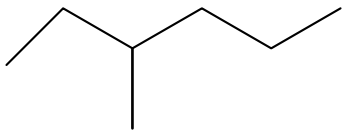
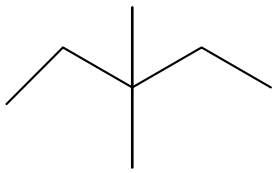
Question Number	Acceptable Answers	Reject	Mark
23(c)	First mark Dative pair of e^- between S and right-hand O (1) Second mark Two bond pairs between S and left-hand O (1) Third mark Two lone pairs on left-hand O, one lone pair on central S and three lone pairs on right-hand O atom (1) If 2 double bonds between sulfur and each oxygen then the third mark can be given for two lone pairs on both oxygens and one lone pair on central S  NOTE ALLOW dots and crosses that have been reversed Lone pair electrons can be shown as separated (rather than having to be paired up) – it is the total number of electrons in each outer shell that matters Stand alone marks If molecule shown as charged then 2 max		3

Question Number	Acceptable Answers	Reject	Mark
23(d)(i)		 benzene ring	1

Question Number	Acceptable Answers	Reject	Mark
23(d)(ii)	$C_7H_{16} \rightarrow C_7H_{14} + H_2$ ALLOW $C_6H_{11}CH_3$ IGNORE state symbols, even if incorrect	Formulae other than molecular formulae Any other structural or displayed formulae	1

Question Number	Acceptable Answers	Reject	Mark
23(d)(iii)	Any ONE of: (a cyclic alkane) has more efficient combustion allows smoother burning increases octane number reduces knocking / less likely to produce pre-ignition is a more efficient fuel burns better / easier to burn /combusts more easily / improves combustion IGNORE (a cyclic alkane): increases the volatility of a fuel "ignites more easily" "is a better fuel" "burns more cleanly" IGNORE (a cyclic alkane) has a lower boiling point mentions of viscosity safer fuel	Less pollution / reduce waste High atom economy Produces useful products / hydrogen Used to make polymers Produces substances in higher demand / more valuable	1

Question Number	Acceptable Answers	Reject	Mark
23(e)(i)	2,2-dimethylpentane IGNORE missing hyphen/missing comma	2-dimethylpentane	1

Question Number	Acceptable Answers	Reject	Mark
23(e)(ii)	 (1)  (1) IGNORE names even if incorrect IGNORE different length bonds IGNORE direction of methyl groups		2

Question Number	Acceptable Answers	Reject	Mark
23(f)(i)	U.V. / U.V.light / light / sunlight ALLOW high temperature	 heat alone	1

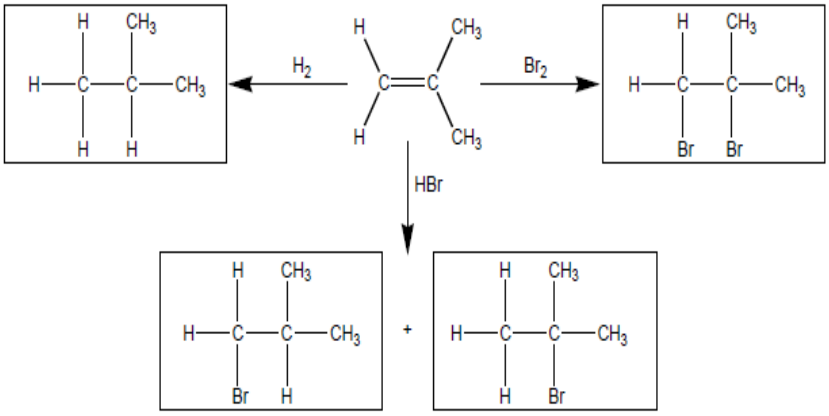
Question Number	Acceptable Answers	Reject	Mark
23(f)(ii)	$Cl_2 \rightarrow Cl\cdot + Cl\cdot$ / $Cl_2 \rightarrow 2Cl\cdot$ IGNORE any curly arrows, even if incorrect IGNORE C_4H_{10} given on both sides		1

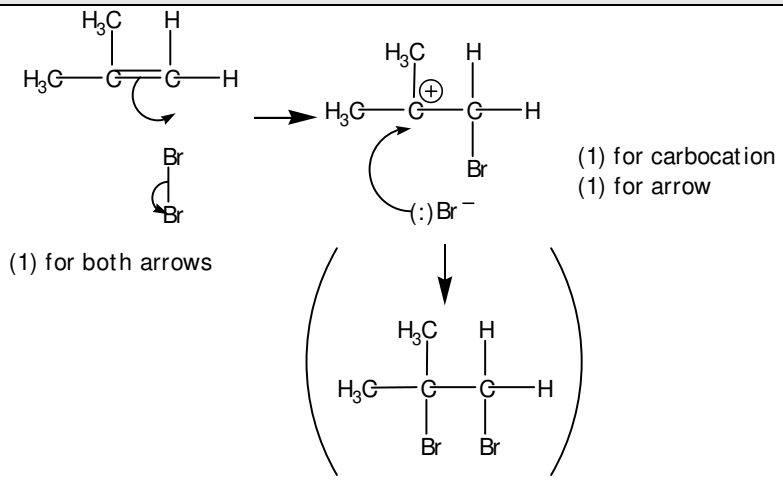
Question Number	Acceptable Answers	Reject	Mark
23(f)(iii)	Homolytic (fission) IGNORE any formulae and arrows	Photolysis (fission) / free radical (fission)	1

Question Number	Acceptable Answers	Reject	Mark
23(f)(iv)	(First propagation step) $C_4H_{10} + Cl\cdot \rightarrow C_4H_9\cdot + HCl$ (1) (Second propagation step) $C_4H_9\cdot + Cl_2 \rightarrow C_4H_9Cl + Cl\cdot$ (1) Formulae can be displayed 'dots' can be anywhere on free radical but no dots at all scores zero ALLOW in either order Incorrect alkane / halogenoalkane but two correct propagation steps scores 1 out of 2	Any reactions involving Hydrogen radicals scores zero Reverse of first reaction	2

Question Number	Acceptable Answers	Reject	Mark
23(f)(v)	Any ONE of: $C_4H_9\cdot + Cl\cdot \rightarrow C_4H_9Cl$ OR $Cl\cdot + Cl\cdot \rightarrow Cl_2$ OR $C_4H_9\cdot + C_4H_9\cdot \rightarrow C_8H_{18}$		1

Total for Question 23 = 18 marks

Question Number	Acceptable Answers	Reject	Mark
24(a)	 (1) for each correct product ALLOW correct displayed / skeletal / semi-skeletal / structural / semi-structural formula in each case ALLOW any order of symbols after or before each carbon ALLOW brackets or no brackets around Br/ CH_3 for example $CH_2BrCH_3CBrCH_3$		4

Question Number	Acceptable Answers	Reject	Mark
24(b)	 First mark Double-headed arrow from alkene must start from somewhere on C=C bond Partial charge on Br_2 molecule must be correct if shown Second mark is for either correct primary or secondary carbocation and is a standalone mark Third mark Double-headed arrow from bromide ion can start from the minus sign, a lone pair on Br^-, or from the Br and can go to the C or the + sign on the intermediate The negative charge must be present on the bromide ion The final product, if shown, must be correct to gain third mark Mechanisms with other electrophiles (e.g. HBr, BrOH) can score 2nd and 3rd marks	Single-headed arrow Bromine / bromide free radicals Single-headed arrow (Penalise again)	3

Question Number	Acceptable Answers	Reject	Mark
24(c)	First mark is for calculating the theoretical maximum mass of ethene from 9.2 g ethanol:- (46 g C_2H_5OH gives 28 g C_2H_4 so 9.2 g C_2H_5OH gives maximum mass of) 5.6 g C_2H_4 (1) Second mark is for calculating the percentage yield from candidate's theoretical maximum mass:- (4.2/5.6 x 100% =) 75 (%) IGNORE s.f. except 1 s.f. OR First mark Amount of ethene = 4.2/28 = 0.15 (mol) and amount of ethanol = 9.2/46 = 0.20 (mol) (1) Second mark % yield = 0.15/0.20 = 75 % (1) NOTE Correct answer with no working scores (2) % yield TE on candidate's theoretical mass / moles only if % yield <100% If molar masses are reversed, award one mark for 27.8%	(0) for $\frac{4.2}{9.2}$ x 100%	2

Total for Question 24 = 9 marks

Question Number	Acceptable Answers	Reject	Mark
* 25(a)	First mark The enthalpy change when one mole of water is produced (1) Second Mark as a result of the reaction between an acid and an alkali / a base (1) OR First Mark The enthalpy change when one mole of H^+ / H_3O^+ / oxonium / hydronium / hydroxonium (ions) (1) Second Mark Reacts with one mole of / excess / just enough OH^- (1) ALLOW First mark The enthalpy change when one mole of acid is (just) neutralized (1) Second Mark By (excess) alkali / base (1) ALLOW reverse argument i.e. base neutralising acid	"Energy required…" for 1st mark	2

Question Number	Acceptable Answers	Reject	Mark
25(b)(i)	5643 without working score 2 marks IGNORE any signs First mark Recognition that volume of solution / mass of solution is 100 (cm^3 / g) (1) Second mark ΔT = 13.5 °C (energy released) = 100 x 4.18 x 13.5 = 5643 (J) (1) ALLOW 5.643 kJ IGNORE s.f. except 1 s.f. IGNORE mol^{-1}	5643 kJ	2

Question Number	Acceptable Answers	Reject	Mark
25(b)(ii)	(Moles HCl = c_{HCl} x V_{HCl} / 1000=) $\frac{2.00 \times 50.0}{1000}$ = 0.1(00) (mol HCl) IGNORE s.f.		1

Question Number	Acceptable Answers	Reject	Mark
25(b)(iii)	$H^+(aq) + OH^-(aq) \rightarrow / \rightleftharpoons H_2O(l)$ NOTE: ALL State symbols AND ALL species are required for the mark ALLOW equations with the "spectator ions" crossed out		1

Question Number	Acceptable Answers	Reject	Mark
25(b)(iv)	$-\frac{5.643}{0.1(00)} = -56.43\ kJ\ mol^{-1}$ First mark: Correct TE for calculations using answers to (b)(i) and (b)(ii) (1) Second mark: Minus sign (1) Third mark: Final answer in units of $kJ\ mol^{-1}$ or kJ/ mol ALLOW correct answer in J mol^{-1} if units given (1) IGNORE case of k and J IGNORE s.f. EXCEPT 1 s.f. NOTE: Correct answer, with or without working, scores (3)	Final answer to 1 s.f. kJ/mol^{-1} or just kJ just J	3

Question Number	Acceptable Answers	Reject	Mark
25(b)(v)	The ionic equation is the same OR number of moles of H^+ ions and OH^- is the same OR number of moles of H^+ ions and water is the same OR number of moles of OH^- ions and water is the same ALLOW Both acid and base are strong and produce 1 mol of water	Just 'forms one mole of water(1)'	1

Total for Question 25 = 10 marks

Total for Section B = 60 Marks

Total for Paper = 80 Marks

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