

Mark Scheme (Results) Summer 2014

GCE Chemistry (6CH01/01)
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

Question Number	Correct Answer	Mark
1	A	1

Question Number	Correct Answer	Mark
2	C	1

Question Number	Correct Answer	Mark
3	A	1

Question Number	Correct Answer	Mark
4	C	1

Question Number	Correct Answer	Mark
5	D	1

Question Number	Correct Answer	Mark
6	D	1

Question Number	Correct Answer	Mark
7	D	1

Question Number	Correct Answer	Mark
8	B	1

Question Number	Correct Answer	Mark
9	D	1

Question Number	Correct Answer	Mark
10	C	1

Question Number	Correct Answer	Mark
11	C	1

Question Number	Correct Answer	Mark
12	B	1

Question Number	Correct Answer	Mark
13	B	1

Question Number	Correct Answer	Mark
14	B	1

Question Number	Correct Answer	Mark
15	A	1

Question Number	Correct Answer	Mark
16	D	1

Question Number	Correct Answer	Mark
17(a)	B	1

Question Number	Correct Answer	Mark
17(b)	A	1

Question Number	Correct Answer	Mark
18	C	1

Question Number	Correct Answer	Mark
19	B	1

Total for Section A: 20 marks

Section B

Question Number	Acceptable Answers	Reject	Mark
20 (a)(i)	(Compound of) carbon and hydrogen ONLY/ENTIRELY/PURELY	" Mixture of carbon and hydrogen only"	1

Question Number	Acceptable Answers	Reject	Mark
20 (a)(ii)	(Contains) only (C—C) single bonds/ only σ bond(s) OR (Contains) no (C=C) double bond(s)/no triple bond(s) OR Cannot undergo addition (reactions) ALLOW Has maximum number of hydrogen atoms / has maximum amount of hydrogen /can form no more bonds IGNORE references to alkanes		1

Question Number	Acceptable Answers	Reject	Mark
20 (b)(i)	Boiling point(s) / boiling temperatures / boiling ranges ALLOW Different sizes of molecules / different chain lengths / different numbers of carbon atoms IGNORE References to melting points / melting temperatures / condensing	Just 'different temperatures' Breaking of hydrocarbon chains	1

Question Number	Acceptable Answers	Reject	Mark
20 (b)(ii)	Save fossil fuels / saves finite resources / saves petrol / saves diesel OR More sustainable OR Uses renewable resources / biodiesel made from 'natural resources' OR Biodiesel is a renewable fuel OR Plants (more) carbon neutral / use of plants improves carbon footprint (of fuel) OR Biodiesel has smaller carbon footprint / zero carbon footprint OR Biodiesel (more) carbon neutral ALLOW Reverse argument for petrol / 'normal' diesel (eg crude oil is non-renewable) IGNORE Less impact on the environment / references to 'environmentally friendly' / less polluting / acid rain IGNORE References to 'global warming' or 'Greenhouse Effect' or 'climate change'.		1

Question Number	Acceptable Answers	Reject	Mark
20 (c)(i)	C₉H₂₀ IGNORE Any structures drawn out		1

Question Number	Acceptable Answers	Reject	Mark
20 (c)(ii)	First mark: Any ONE of:- (Greater) demand for smaller molecules / (Greater) demand for smaller alkanes / (Greater) demand for alkenes / To make more useful products / To make more reactive product / To make smaller molecules / To make shorter molecules / To make alkenes / To make shorter chains NOTE: ALLOW 'To produce fuel(s)' (1) Second mark: (High temperatures needed to) break (the C-C and / or C-H) bonds OR To break (down) the (hydrocarbon) chain(s) / To break (down) the molecule(s) / To split the molecule(s) / To break the hydrocarbon OR (Reaction is) endothermic ALLOW To overcome the (high) activation energy / the reaction has a high activation energy / provide activation energy IGNORE C-C bond is stable References to increasing rate (of reaction) References to yield / equilibrium References to efficiency / producing less CO (1) Marks are stand-alone	No 2nd mark if any of the following are mentioned: Separation of molecules Breaking intermolecular forces References to (high) boiling temperatures / (high) boiling points References to (high) melting temperatures / (high) melting points	2

Question Number	Acceptable Answers	Reject	Mark
20 (d)(i)	(Substance that) produces energy or produces heat IGNORE:- References to 'power' References to just 'exothermic' References to burning or combustion or heating the fuel or reference to oxygen		1

Question Number	Acceptable Answers	Reject	Mark
20 (d)(ii)	$\text{C}_4\text{H}_{10}(\text{g}) + 6\frac{1}{2}\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 5\text{H}_2\text{O}(\text{l})$ OR $\text{C}_4\text{H}_{10}(\text{g}) + 6.5\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 5\text{H}_2\text{O}(\text{l})$ OR $\text{C}_4\text{H}_{10}(\text{g}) + \frac{13}{2}\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 5\text{H}_2\text{O}(\text{l})$ OR $2\text{C}_4\text{H}_{10}(\text{g}) + 13\text{O}_2(\text{g}) \rightarrow 8\text{CO}_2(\text{g}) + 10\text{H}_2\text{O}(\text{l})$ OR Any other correct multiples Correct species (1) Balancing and state symbols correct (1) 2 nd mark is dependent on the 1 st mark	$\text{H}_2\text{O}(\text{g})$ $\text{C}_4\text{H}_{10}(\text{l})$	2

Question Number	Acceptable Answers	Reject	Mark
20(d)(iii)	$\text{C}_4\text{H}_{10} + 4\frac{1}{2}\text{O}_2 \rightarrow 4\text{CO} + 5\text{H}_2\text{O}$ OR $\text{C}_4\text{H}_{10} + 4.5 \text{O}_2 \rightarrow 4\text{CO} + 5\text{H}_2\text{O}$ OR $\text{C}_4\text{H}_{10} + \frac{9}{2} \text{O}_2 \rightarrow 4\text{CO} + 5\text{H}_2\text{O}$ OR $2\text{C}_4\text{H}_{10} + 9 \text{O}_2 \rightarrow 8\text{CO} + 10\text{H}_2\text{O}$ OR Any other correct multiples IGNORE State symbols even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
20(d)(iv)	Limited (supply of) air / oxygen OR insufficient (supply of) air / oxygen OR Oxygen / air not in excess OR Not enough air / not enough oxygen ALLOW 'Lack of oxygen' / lack of ventilation IGNORE "It is not completely oxidized"	'no air' / 'no oxygen'	1

Question Number	Acceptable Answers	Reject	Mark
20(e)(i)	First mark Calculation of the sum of the M_r values of all the products = 217.8 If using Br = 80, M_r = 218 (1) Second mark Calculation of % atom economy using value of total M_r [= $\frac{136.9}{217.8}$ (x 100%)] = 62.856 (%) (1) NOTE If using Br = 80, final answer = 62.844 (%) ALLOW ECF for the 2nd mark on an incorrect total M_r value IGNORE sf except 1 sf Correct answer with no working (2) Check rounding of answer NOTE If one error only is made, (1) mark awarded	For M_r = 217.8, 62.8% (no 2nd mark, as this is a rounding error)	2

Question Number	Acceptable Answers	Reject	Mark
*20(e)(ii)	First mark: Initiation (step) (1) Second mark: $\text{Br}-\text{Br} \rightarrow \text{Br}\bullet + \text{Br}\bullet$ / $\text{Br}_2 \rightarrow 2\text{Br}\bullet$ (1) Third mark: Propagation (steps) (1) Fourth and fifth marks: $\text{Br}\bullet + \text{C}_4\text{H}_{10} \rightarrow \text{C}_4\text{H}_9\bullet + \text{HBr}$ (1) $\text{Br}_2 + \text{C}_4\text{H}_9\bullet \rightarrow \text{C}_4\text{H}_9\text{Br} + \text{Br}\bullet$ (1) Allow in either order Sixth mark: Termination (step(s)) (1) Seventh mark: Any one of $\text{Br}\bullet + \text{Br}\bullet \rightarrow \text{Br}_2$ OR $\text{C}_4\text{H}_9\bullet + \text{Br}\bullet \rightarrow \text{C}_4\text{H}_9\text{Br}$ OR $\text{C}_4\text{H}_9\bullet + \text{C}_4\text{H}_9\bullet \rightarrow \text{C}_8\text{H}_{18}$ (1)	H• (the fourth and fifth marks cannot be awarded if H• appears in either propagation step)	7

(Total for Question 20 = 21 marks)

Question Number	Acceptable Answers	Reject	Mark
21(a)	(The energy / enthalpy change that accompanies the formation of) one mole of a(n ionic) compound (1) ALLOW as alternative for compound: lattice / crystal / substance / solid / product / salt from (its) gaseous ions (1) IGNORE References to 'standard conditions' or any incorrect standard conditions ALTERNATIVE RESPONSE If no mark(s) already awarded from above, can answer by giving:- energy change / enthalpy change per mole (1) $2\text{Na}^+(\text{g}) + \text{O}^{2-}(\text{g}) \rightarrow \text{Na}_2\text{O}(\text{s})$ (1) NOTE If lattice energy of dissociation is given (e.g. "energy required to break down 1 mol of an ionic lattice into its gaseous ions") max (1) for the 2nd scoring point 'gaseous ions'	'energy required' / 'energy needed' / 'energy it takes' 'from one mole of gaseous ions' (no 2nd mark) 'from gaseous elements' (no 2nd mark)	2

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	All seven letters correct (3) Five OR six letters correct (2) Three OR four letters correct (1) ALLOW Either D or 2D Either C or 2C ALLOW Correct numerical values (see question paper) may be given as an alternative to the correct letters		3

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	FIRST, CHECK THE FINAL ANSWER IF answer = $-2520 \text{ (kJ mol}^{-1}\text{)}$ then award (2) marks, with or without working Otherwise look for $-414 = (2 \times 108) + 249 + (2 \times 496) + (-141) + 790 + \Delta H_{LE}$ OR $\Delta H_{LE} = -414 - [(2 \times 108) + 249 + (2 \times 496) + (-141) + 790]$ OR A correct expression using letters e.g. $F = (2)D + E + (2)C + A + B + G$ (1) $(-414 - 2106) = -2520 \text{ (kJ mol}^{-1}\text{)}$ (1) NOTE ALLOW for 1 mark: -1692 (wrong sign for 414) -1916 (2×108 and 2×496 not used for Na^+) -2412 (2×108 not used for Na^+) -2024 (2×496 not used for Na^+) $+2520$ (wrong sign for final answer) -2802 (sign changed for 1st electron affinity of oxygen) -2395.5 (atomization of oxygen halved) NOTE Penalise incorrect units (e.g. kJ mol) ONCE only NO ECF from incorrect answers to (b)(i)	$-1088 \text{ (kJ mol}^{-1}\text{)}$ scores (0) overall (as two errors) $(+1088 \text{ (kJ mol}^{-1}\text{)})$ also scores (0) overall (as several errors)	2

Question Number	Acceptable Answers	Reject	Mark
*21(c)	ALLOW reverse argument where appropriate First mark MgO more exothermic (than MgS) IGNORE 'greater' / 'higher' / 'larger' (1) Second mark S^{2-} larger than O^{2-} (1) Third mark Charges on O^{2-} and S^{2-} same OR Charges on (all) ions same OR S^{2-} smaller charge density than O^{2-} NOTE This mark is awarded if both formulae for the ions O^{2-} and S^{2-} are mentioned (1) Fourth mark O^{2-} (forms) stronger (electrostatic) attractions (than S^{2-}) IGNORE just 'stronger (ionic) bonds' (1) Penalise ONCE ONLY the use of the word 'atom(s)' or 'molecule(s)' / use of formulae such as 'Mg' 'O' 'O₂', etc. AND/OR Penalise ONCE ONLY use of words such as just 'magnesium' (instead of magnesium ions/Mg^{2+}) and/or just 'oxygen' (instead of oxide ions/O^{2-}) Mark each point independently	"MgS is larger than MgO" S^{2-} has a larger atomic radius than O^{2-}	4

(Total for Question 21 = 11 marks)

Question Number	Acceptable Answers	Reject	Mark
22(a)	$(1s^2) 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$ OR $(1s^2) 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$ ALLOW capital S P D Allow subscripts (e.g. $(1s^2) 2s_2 2p_6 3s_2 3p_6 4s_2 3d_8$)		1

Question Number	Acceptable Answers	Reject	Mark
22(b)	$(A_r \text{ for Ni}) = (58 \times 0.6902) + (60 \times 0.2732) + (62 \times 0.0366)$ or a correct fraction using percentages (1) $(= 58.6928)$ [calculator value] $= 58.69$ (must be to 2 dp) (1) 2 nd mark CQ on numbers transcribed Correct answer with no working (2) IGNORE Units of any kind (e.g. 'g', 'g mol ⁻¹ ', 'amu', etc.)	58.68 (as rounding error)	2

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	Moles of nickel = $\frac{5.87}{58.7}$ = 0.1(00) (mol) (1) Moles CO = 0.1(00) x 4 = 0.4(00) (mol) Answer CQ on 4 x mol Ni (1) Volume of CO = 0.4(00) x 24 (dm³) = 9.6 (dm³) ALLOW 9600 cm³ Answer CQ on 24 x mol CO (1) Correct answer with no working scores (3)	9.6 dm³ mol⁻¹ (no 3rd mark) 9.6 dm⁻³ (no 3rd mark) OR Any other incorrect units (no 3rd mark)	3

Question Number	Acceptable Answers	Reject	Mark
22(c)(ii)	(Number of CO molecules = 0.400 x 6.02 x 10²³) = 2.408 x 10²³ Answer CQ on moles / volume of CO in (c)(i) IGNORE sf except 1 sf IGNORE Any units, even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
22(d)(i)	Moles of NiO = $\frac{1.494}{74.7}$ = 0.02(00) (mol) (1) Moles HNO₃ = 0.02(00) x 2 = 0.04(00) (mol) Answer CQ on 2 x mol NiO (1) Volume of HNO₃ = $\frac{0.04(00) \times 1000}{2.00}$ = 20(.0) (cm³) ALLOW 0.02(00) dm³ Answer CQ on mol HNO₃ (1) Correct answer with no working scores (3) Penalise wrong units ONCE only		3

Question Number	Acceptable Answers	Reject	Mark
22(d)(ii)	To ensure all the acid reacts / all the acid is used up / all the acid is neutralized IGNORE References to 'yield' / reaction going to completion / just 'acid is the limiting reagent'	To ensure all the reactants are used up	1

Question Number	Acceptable Answers	Reject	Mark
22(d)(iii)	Fizzing / effervescence / frothing / bubbles / gas released IGNORE spilling (over) / spillage References to 'vigorous', 'exothermic', 'violent' / just 'safety'	(Mixture) boils Quantity of reagents / 'displacement' of solution on adding solid	1

Question Number	Acceptable Answers	Reject	Mark
22(d) (iv)	$\text{NiCO}_3(\text{s}) + 2\text{HNO}_3(\text{aq}) \rightarrow \text{Ni}(\text{NO}_3)_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ ALLOW correct ionic equation $\text{NiCO}_3(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Ni}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ All species correct (1) Balancing and all state symbols correct (1) 2nd mark is dependent on 1st mark (ie all species correct)	H ₂ CO ₃ (aq) scores (0) overall	2

Question Number	Acceptable Answers	Reject	Mark
*22(d)(v)	First mark: Filter (off the excess nickel(II) carbonate / solid) (1) Second mark: Boil / heat (to drive off some of the water) (1) IGNORE just 'evaporation' (as the technique of boiling / heating is required here) Third mark: Leave to cool / leave to crystallize / evaporate (water) slowly / leave (for water) to evaporate (1) Fourth mark: Dry (the crystals) (1) IGNORE Any washing of the crystals immediately prior to drying them NOTE If heat to dryness in the second stage, award (1) mark if filtration is first stage If filtration is not the first stage, award (1) mark for steps 2, 3 and 4 all correct	Just "warm" the filtrate / solution OR 'heat the filtrate to dryness' (Adding to a) drying agent Use of Bunsen burner or direct heating to dry crystals	4

(Total for Question 22 = 18 marks)

Question Number	Acceptable Answers			Reject	Mark
23(a)	(Protons)	18			1
	(Electrons)	18			
	(Neutrons)	22			
	All three numbers correct for the mark				

Question Number	Acceptable Answers	Reject	Mark
23(b)	(Position in the Periodic Table) depends upon atomic number / proton number OR Ar (atom) has (one) fewer proton(s) (than K atom) OR K (atom) has (one) more proton(s) (than Ar atom) OR K has atomic number 19 (whereas) Ar has atomic number 18 OR Ar has 18 protons, K has 19 protons IGNORE 'Elements are not arranged in order of (relative) atomic mass' IGNORE Mention of numbers of electrons / numbers of shells (of electrons) IGNORE Arranged in vertical groups in accordance to properties / Argon is a noble gas		1

Question Number	Acceptable Answers	Reject	Mark
23(c)	First mark Property / trend / pattern ALLOW Any named property (e.g. atomic radius, ionization energy, melting temperature) (1) Second mark Repeated (across each period) OR Regular (across each period) OR Re-occurring (across each period) (1) NOTE Statement such as: "A repeating trend across a period / across each period" scores (2)		2

Question Number	Acceptable Answers	Reject	Mark
23(d)(i)	Phosphorus / P / P₄ OR Sulfur / S / S₈ OR Chlorine / Cl / Cl₂ IGNORE Argon / Ar		1

Question Number	Acceptable Answers	Reject	Mark
23(d)(ii)	(The covalent) bonds are strong (1) (therefore) a lot of energy is required to break the bonds / a lot of energy is needed to overcome the attractions (between atoms) / 'more energy' is required to break the bonds / 'more energy' is needed to overcome the attractions (between atoms) / 'greater amount of energy' is required to break the bonds / 'greater amount of energy' is needed to overcome the attractions (between atoms) (1)	MENTION OF ANY OF THE FOLLOWING SCORES (0) OVERALL '(simple) molecular silicon' (0) 'molecules of silicon' (0) 'silicon has ions' / 'silicon is ionic' (0) 'intermolecular forces' / 'van der Waals' forces' / 'London forces' / 'forces between the molecules' (0) 'metallic bonding' (0)	2

Question Number	Acceptable Answers	Reject	Mark
23(d)(iii)	ALLOW reverse arguments in each case Any two from four:- ●magnesium ions / magnesium atoms are smaller (than sodium ions / sodium atoms) (1) NOTE: Allow symbols (e.g. Mg or Mg²⁺) ●magnesium ions are Mg²⁺ whereas sodium ions are Na⁺ OR Mg²⁺ / magnesium ions have a larger charge (density) (than Na⁺ /sodium ions) (1) [NOTE: It follows that the statement that "Mg²⁺ ions are smaller than Na⁺ ions" would score the first two scoring points above] ●magnesium has more delocalised electrons (than sodium) (1) IGNORE 'free electrons' IGNORE just 'sea of electrons' ●magnesium is close-packed (but sodium is not close-packed) (1) Third mark (stand-alone): · more / a lot of (heat) energy is needed to break (metallic) bonds in Mg (than in Na) OR · attraction between the positive ions and (delocalised) electrons is stronger in magnesium (than in sodium) (1)	attraction between nucleus and (delocalised) electrons (no third mark) mention of intermolecular forces / molecules (no third mark)	3

	IGNORE Just 'metallic bonding in Mg stronger than that in Na'	ionic bonding (no third mark) attraction between Mg^{2+} ions (no third mark) NOTE: arguments based on ionization energies scores (0) overall OR any suggestion of removal of outer shell electrons as part of the melting process scores (0) overall	
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(Total for Question 23 = 10 marks)

TOTAL FOR SECTION B = 60 marks

TOTAL FOR PAPER = 80 marks

