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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)	**C_9H_{20}** 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)	$C_4H_{10}(g) + 6½O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$ OR $C_4H_{10}(g) + 6.5O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$ OR $C_4H_{10}(g) + \frac{13}{2} O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$ OR $2C_4H_{10}(g) + 13\ O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$ OR Any other correct multiples Correct species **(1)** Balancing and state symbols correct **(1)** 2nd mark is dependent on the 1st mark	H_2O(**g**) C_4H_{10}(**l**)	**2**

Question Number	Acceptable Answers	Reject	Mark
20(d)(iii)	$C_4H_{10} + 4½O_2 \rightarrow 4CO + 5H_2O$ OR $C_4H_{10} + 4.5\ O_2 \rightarrow 4CO + 5H_2O$ OR $C_4H_{10} + \frac{9}{2} O_2 \rightarrow 4CO + 5H_2O$ OR $2C_4H_{10} + 9\ O_2 \rightarrow 8CO + 10H_2O$ OR Any other correct multiples IGNORE State symbols even if incorrect		**1**

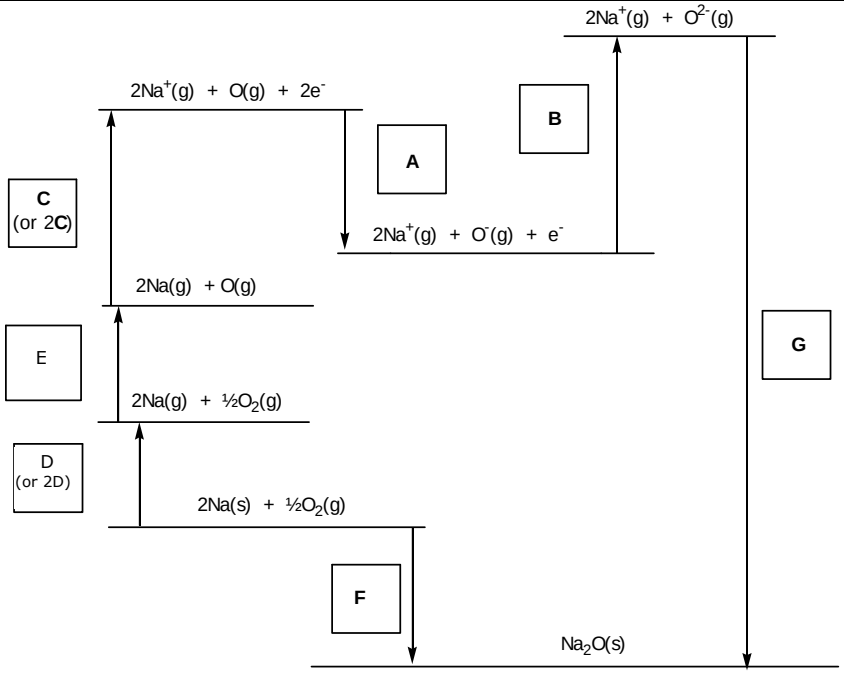
Question Number	Acceptable Answers	Reject	Mark
20(d)(iv)	Limited (supply of) air / oxygen OR insufficient (supply of) air / oxygen OR Oxygen / air not in excess OR Not enough air / not enough oxygen ALLOW 'Lack of oxygen' / lack of ventilation IGNORE "It is not completely oxidized"	'**no** air' / '**no** 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:** Br—Br → Br• + Br• / Br_2 → 2Br• **(1)** **Third mark:** **Propagation** (steps) **(1)** **Fourth and fifth marks:** Br• + C_4H_{10} → C_4H_9• + HBr **(1)** Br_2 + C_4H_9• → C_4H_9Br + Br• **(1)** Allow in either order **Sixth mark:** **Termination (**step(s) **(1)** **Seventh mark:** **Any one of** Br• + Br• → Br_2 OR C_4H_9• + Br• → C_4H_9Br OR C_4H_9• + C_4H_9• → C_8H_{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)** $2Na^+(g) + O^{2-}(g) \rightarrow Na_2O(s)$ **(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 (kJ mol^{-1})** **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** (kJ mol^{-1}) **(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 (kJ mol^{-1}) scores **(0)** overall (as two errors) (+)1088 (kJ mol^{-1}) 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' 'O_2', 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 for Ni) = (58 x 0.6902) + (60 x 0.2732) + (62 x 0.0366) or a correct fraction using percentages **(1)** (= 58.6928) [calculator value] = 58.69 (**must be to 2 dp**) **(1)** 2nd 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 (dm^3) = 9.6 (dm^3) ALLOW 9600 **cm^3** Answer CQ on 24 x mol CO **(1)** Correct answer with no working scores **(3)**	9.6 dm^3 **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 10^{23}) = 2.408 x 10^{23} 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 HNO_3 = 0.02(00) x 2 = 0.04(00) (mol) Answer CQ on 2 x mol NiO **(1)** Volume of HNO_3 = $\frac{0.04(00) \times 1000}{2.00}$ = 20(.0) (cm^3) ALLOW 0.02(00) **dm^3** Answer CQ on mol HNO_3 **(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)	$NiCO_3$(**s**) + $2HNO_3$(**aq**) → $Ni(NO_3)_2$(**aq**) + H_2O(**l**) + CO_2(**g**) ALLOW correct ionic equation $NiCO_3$(**s**) + $2H^+$(**aq**) → Ni^{2+}(**aq**) + H_2O(**l**) + CO_2(**g**) All species correct **(1)** Balancing and all state symbols correct **(1)** 2nd mark is dependent on 1st mark (ie all species correct)	H_2CO_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** (Electrons) **18** (Neutrons) **22** All three numbers correct for the mark		**1**

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 / P_4 OR Sulfur / S / S_8 OR Chlorine / Cl / Cl_2 IGNORE Argon / Ar		**1**

Question Number	Acceptable Answers	Reject	Mark
23(d)(ii)	(The covalent) **bonds** are **strong** (throughout the lattice) **(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 small**er** (than sodium ions / sodium atoms) **(1)** **NOTE:** Allow symbols (e.g. Mg or Mg^{2+}) ●magnesium **ions** are Mg^{2+} whereas sodium **ions** are Na^{+} OR Mg^{2+} / magnesium **ions** have a larg**er** charge (density) (than Na^{+} /sodium **ions**) **(1)** **[NOTE:** It follows that the statement that "Mg^{2+} 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 strong**er** 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**	

(Total for Question 23 = 10 marks)

TOTAL FOR SECTION B = 60 marks

TOTAL FOR PAPER = 80 marks

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