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Mark Scheme (Results)
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GCE

GCE Chemistry (6CH01/01)

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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	Answer	Mark
1	C	**1**

Question Number	Answer	Mark
2	D	**1**

Question Number	Answer	Mark
3	C	**1**

Question Number	Answer	Mark
4	C	**1**

Question Number	Answer	Mark
5	B	**1**

Question Number	Answer	Mark
6(a)	D	**1**

Question Number	Answer	Mark
6(b)	C	**1**

Question Number	Answer	Mark
6(c)	A	**1**

Question Number	Answer	Mark
7	C	**1**

Question Number	Answer	Mark
8	A	**1**

Question Number	Answer	Mark
9	B	**1**

Question Number	Answer	Mark
10	B	**1**

Question Number	Answer	Mark
11	B	**1**

Question Number	Answer	Mark
12	C	**1**

Question Number	Answer	Mark
13	D	**1**

Question Number	Answer	Mark
14	B	**1**

Question Number	Answer	Mark
15	A	**1**

Question Number	Answer	Mark
16	D	**1**

Question Number	Answer	Mark
17	D	**1**

Question Number	Answer	Mark
18	B	**1**

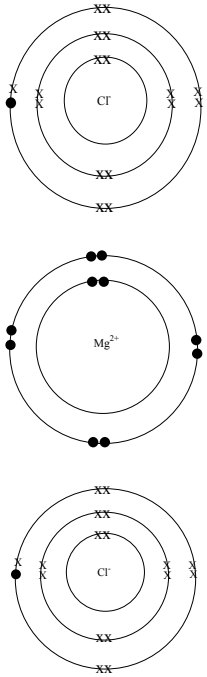
Section B

Question Number	Acceptable Answers	Reject	Mark
19(a)(i)	$(1s^2)2s^22p^63s^2$ *ALLOW* subscripts *IGNORE* capital letters *ALLOW* 2p as p_x p_y p_z with two e^- in each	Noble gas core	**1**

Question Number	Acceptable Answers	Reject	Mark
19(a)(ii)	$(1s^2)2s^22p^63s^23p^5$ *ALLOW* subscripts *IGNORE* capital letters *ALLOW* 2p as p_x p_y p_z with two e^- in each ALLOW 3p as p_x p_y p_z with two, two, one e^- in each	Noble gas core	**1**

Question Number	Acceptable Answers	Reject	Mark
19(b)(i)	$Mg_{(s)} + Cl_{2(g)} \rightarrow MgCl_{2(s)}$ Species and balancing **(1)** State symbols CQ on correct species **(1)** *NOTE* $Mg_{(s)} + 2Cl_{(g)} \rightarrow MgCl_{2(s)}$ scores **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
19(b)(ii)	Ionic / electrovalent *IGNORE* "lattice"/"bonding"/"giant"		**1**

Question Number	Acceptable Answers	Reject	Mark
19(b)(iii)	Correct number of electrons on each ion **(1)** Correct charges and symbols for each ion **(1)** Correct ratio of ions **(1)**  *ALLOW* **all** dots or all crosses *ALLOW* correct charges shown outside the ions *ALLOW* Cl^- correctly with "2" in front **or** after the Cl^-	Any covalency shown **(0)** i.e. any overlap of circles (e.g. Mg with a Cl or a Cl with a Cl) scores **(0) overall,** even if correct charges on ions and/or ratio of ions has been shown	**3**

Question Number	Acceptable Answers	Reject	Mark
19(c)	(Giant) metallic / metal		**1**

Question Number	Acceptable Answers	Reject	Mark
19(d) **QWC**	Magnesium **ion** / Mg^{2+} has a larger charge (density) (than the sodium ion / Na^{+}) **OR** Magnesium/Mg/Mg atom/Mg^{2+} (ion) contributes two electrons/more electrons (to the "sea" of electrons) **(1)** magnesium ions / Mg^{2+} smaller (than sodium ions) **(1)** *NOTE* "Mg^{2+} is smaller than Na^{+}" would score first 2 marks above magnesium ions / Mg^{2+} have greater attraction for ("sea" of) electrons (than sodium ions / Na^{+}) **OR** More **energy/heat** required to overcome (attractive) forces/bonds (between cations and "sea" of electrons) in magnesium (compared to sodium) **(1)** Mark each point independently	Any references to the bonding being ionic scores **(0)** overall Any references to "molecules"/intermolecular forces scores **(0)** overall **JUST** "stronger bonds in Mg" **JUST** "stronger bonds in Mg"	**3**

Question Number	Acceptable Answers	Reject	Mark
20 (a)(i)	• **Idea of impact by electrons, with energy:** fast **electrons** strike sample / high energy **electrons** / accelerated **electrons** / **electrons** fired at sample/sample bombarded with **electrons**/blasted with **electrons** from electron gun **(1)** • **Idea of electron removal:** removes an electron/knocks out electron(s)/X → $X^+ + e^-$ **(1)** Mark each point independently	"electron gun" **alone** an incorrect equation negates second mark	**2**

Question Number	Acceptable Answers	Reject	Mark
20(a)(ii)	Electric field/electrostatic field / charged plates / voltage differential across plates/negative field/negatively charged plates	Electric current/electric coil/magnetic field	**1**

Question Number	Acceptable Answers	Reject	Mark
20(a)(iii)	Magnetic field / magnet / electromagnet / magnetic plates	"Negative magnetic field"	**1**

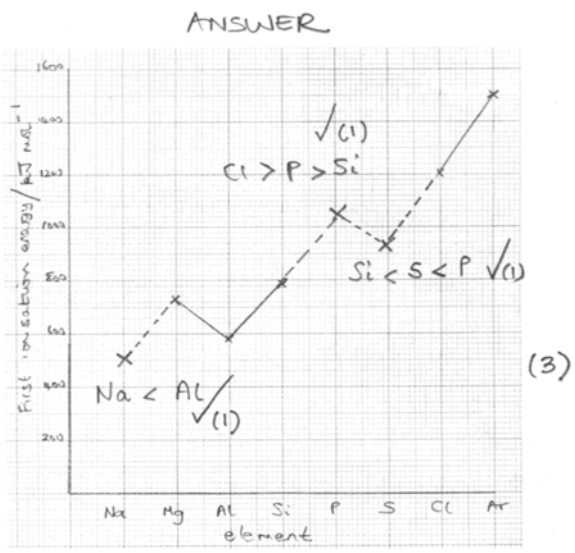
Question Number	Acceptable Answers	Reject	Mark
20(b)	((50.0 x 4.3) + (52.0 x 83.8) + (53.0 x 9.5) + (54.0 x 2.4)) ÷ 100 **(1)** = 52.1 (must be to 3 SF) **(1)** NOTE: 52.057/52.06 scores **(1)** with or without any working *IGNORE* g or g mol^{-1} but **wrong units** lose a mark Correct answer with no working **(2)**		**2**

Question Number	Acceptable Answers	Reject	Mark
20(c)	Same electronic structures/same electronic configurations/same electronic arrangements/same number of electrons/same total number of electrons *ALLOW* "same number of protons and same number of electrons"	**Just** "same number of **outer** electrons" **(0)** OR **Just** "same number of protons" **(0)**	**1**

Question Number	Acceptable Answers	Reject	Mark
20(d)	d (block) *ALLOW* "D" (BLOCK) *IGNORE* "transition metal/element" **if** d (block) stated in answer *IGNORE* "group"	**Just** transition element(s) / transition metal(s)	**1**

Question Number	Acceptable Answers	Reject	Mark
21(a)	Enthalpy / (heat) energy / heat **required** **OR** enthalpy / (heat) energy / heat **change (1)** to remove one electron **(1)** from each atom of **one mole** of **gaseous** atoms **OWTTE** **(1)** (e.g. "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.	"Energy **given out**…." for first mark. If an incorrect equation is given after a correct definition, **(2)** scored.	**3**

Question Number	Acceptable Answers	Reject	Mark
21(b)	$Na^{+}_{(g)} \rightarrow Na^{2+}_{(g)} + e^{-}$ **OR** $Na^{+}_{(g)} - e^{-} \rightarrow Na^{2+}_{(g)}$ Species **(1)** *ALLOW* **"e" for "e^{-}"** State symbols **(1)** 2nd mark is CQ on 1st The following score max **(1):** $X^{+}_{(g)} \rightarrow X^{2+}_{(g)} + e^{-}$ **(1)** **OR** $X^{+}_{(g)} - e^{-} \rightarrow X^{2+}_{(g)}$ **(1)** $Na_{(g)} \rightarrow Na^{2+}_{(g)} + 2e^{-}$ **(1)** OR $Na_{(g)} \rightarrow Na^{+}_{(g)} + e^{-}$ **(1)** **OR** $Na^{+}_{(g)} + e^{-} \rightarrow Na^{2+}_{(g)}$ **(1)** **OR** $Na^{+}_{(g)} - e^{-} \rightarrow Na^{2+}_{(g)} + e^{-}$ **(1)**	"e^{2-}" $Na^{2+}_{(g)} + e^{-} \rightarrow Na^{+}_{(g)}$ **(0)**	**2**

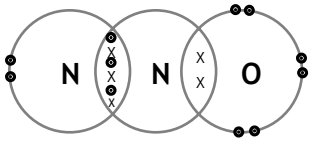
Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	 Correct line alone can score all 3 marks with no points specifically plotted		**3**

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii) **QWC**	More protons / greater nuclear charge/proton number increases **(1)** *ALLOW* "effective nuclear charge increases across the Period" **outer** electrons in same shell / energy level **OR** same shielding **OR** similar shielding **OR** decrease in atomic radius **OR** outer electron closer to nucleus **OR** attracting the same number of (occupied) electron shells / energy levels **(1)** greater (force of) attraction between nucleus and (outer) electron(s) / (outer) electron(s) held more strongly by nucleus **(1)** Mark each point independently	**Just** "increasing atomic number"	**3**

Question Number	Acceptable Answers	Reject	Mark
21(c)(iii) QWC	(Outermost) **electron** in (3-)**p sub**-shell/**sub**-level/orbital **(1)** of higher energy **OR** (slightly) shielded by (3-)**s** (electrons) **OR** (sub-shell) further from nucleus **(1)** *NOTE:* Penalise use of the terms "s-shell" or "p-shell" **once** only.		**2**

Question Number	Acceptable Answers	Reject	Mark
21(d)	S^- S S^+		**1**

Question Number	Acceptable Answers	Reject	Mark
22(a)	(Electrostatic attraction between two nuclei and the) **shared pair (1)** **of electrons** (between them) **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
22(b)	(Dative) pair of e^- between N and O **(1)** Three bond pairs between N and N **(1)** Lone pair on left-hand N **and** three lone pairs on O atom **(1)**  *ALLOW* dots and crosses **OR** all dots **OR** all crosses Stand alone marks Non-bonding electrons on N and O do **not** have to be shown **in pairs**		**3**

Ignore sig figs in this question

Question Number	Acceptable Answers	Reject	Mark
23(a)(i)	Energy absorbed = 30 x 4.18 x 4.9 = 614 (J) Note: 610 to 2 sig figs 614.5 to 4 sig figs 614.46 to 5 sig figs **Ignore any signs, + OR -** Answer alone scores the mark *ALLOW* "0.614 **kJ**"	615 "614 **kJ**" etc	**1**

Question Number	Acceptable Answers	Reject	Mark
23(a)(ii)	Moles = $\frac{2.00}{100}$ = 0.02(00)(mol) Answer alone scores the mark *ALLOW* 0.01998 etc for use of Mr = 100.1		**1**

Question Number	Acceptable Answers	Reject	Mark
23(a)(iii)	$\Delta H^{\ominus}_2 =$ $\frac{\text{Answer to (a)(i) **in kJ**}}{\text{Answer to (a)(ii)}}$ $= \frac{0.614}{0.02(00)}$ ($\Delta H^{\ominus}_2$) = **+**31 / +30.7 (kJ mol^{-1}) **(2)** Positive sign **(1) stand alone** Answer **(1)** If mass of solution used is 32 g in a(i), answer is $\Delta H^{\ominus}_2$ = +32.8 / +33 (kJ mol^{-1}) If mass of solution used is 2 g in a(i), $\Delta H^{\ominus}_2$ = +2.05 / +2.0 / +2.048 (kJ mol^{-1})		**2**

Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	$\Delta H^{\ominus}_1 = 2 \times \Delta H^{\ominus}_2 - \Delta H^{\ominus}_3$		**1**

Question Number	Acceptable Answers	Reject	Mark
23(b)(ii)	$\Delta H^{\ominus}_1$ = 2 x +31 – (-34) ($\Delta H^{\ominus}_1$) = + 96 (kJ mol^{-1}) OR 2 x +30.7 – (-34) = +95.4 / +95 Answer **(1)** Positive sign **(1)** *NOTE:* For +ve answers, penalise the omission of the "+" sign ONCE ONLY in (a)(iii) and (b)(ii) Consequential on (a)(iii) and formula in (b)(i) – **the arithmetic must be checked** *ALLOW:* + 96 /+95.4 / +95 (kJ mol^{-1}) **(2) EVEN IF $\Delta H^{\ominus}_1 = \Delta H^{\ominus}_2 - \Delta H^{\ominus}_3$ GIVEN IN (b)(i)** *NOTE* If use $\Delta H^{\ominus}_1 = \Delta H^{\ominus}_2 - \Delta H^{\ominus}_3$ and mass of solution used is 30 g $\Delta H^{\ominus}_1$ = +65 (kJ mol^{-1}) If use $\Delta H^{\ominus}_1 = \Delta H^{\ominus}_2 - \Delta H^{\ominus}_3$ and mass of solution used is 32 g $\Delta H^{\ominus}_1$ = +67 (kJ mol^{-1}) If use $\Delta H^{\ominus}_1 = \Delta H^{\ominus}_2 - \Delta H^{\ominus}_3$ and mass of solution used is 2 g $\Delta H^{\ominus}_1$ = +36 (kJ mol^{-1}) If use $\Delta H^{\ominus}_1 = 2\Delta H^{\ominus}_2 - \Delta H^{\ominus}_3$ and mass of solution used is 32 g $\Delta H^{\ominus}_1$ = +100 (kJ mol^{-1}) If use $\Delta H^{\ominus}_1 = 2\Delta H^{\ominus}_2 - \Delta H^{\ominus}_3$ and mass of solution used is 2 g $\Delta H^{\ominus}_1$ = +38(kJ mol^{-1})		**2**

Question Number	Acceptable Answers	Reject	Mark
23(c)(i)	**Error for balance:** = (±) **2 x** $\frac{0.01}{2.00}$ x 100% = (±) 1.00%/1.0%/1% **(1)** ALLOW (±) 0.5% also scores **(1)** Correct answer with no working scores **(1)** **Error for measuring cylinder:** = (±) $\frac{0.5}{30}$ x 100% = (±) 1.7%/1.67% **(1)** Correct answer with no working scores **(1)**	1.6(6)% **(0)**	**2**

Question Number	**Acceptable Answers**	Reject	Mark
23(c)(ii)	Pipette or burette	"biuret"	**1**

Question Number	Acceptable Answers	Reject	Mark
24(a)	C_nH_{2n+2}		**1**

Question Number	Acceptable Answers	Reject	Mark
24(b)(i)	Cracking		**1**

Question Number	Acceptable Answers	Reject	Mark
24(b)(ii)	Reforming / dehydrogenation		**1**

Question Number	Acceptable Answers	Reject	Mark
24(c)	Skeletal		**1**

Question Number	Acceptable Answers	Reject	Mark
24(d)(i)	C_9H_{20}	Structural / displayed formulae	**1**

Question Number	Acceptable Answers	Reject	Mark
24(d)(ii)	3-ethyl-4-methylhexane *ALLOW* methyl before ethyl 4-methyl-3-ethylhexane 3-methyl-4-ethylhexane 4-ethyl-3-methylhexane 3,4-ethylmethylhexane *IGNORE* incorrect "punctuation"		**1**

Question Number	Acceptable Answers	Reject	Mark
24(e)(i)	**Enthalpy change Step A:** $\bar{E}$(C-H) + - $\bar{E}$ (H-Cl) = + 413 + (-432) = - 19 (kJ mol^{-1}) **(1)** Correct answer with no working **(1)** **Enthalpy change Step B:** $\bar{E}$(C-H) + - $\bar{E}$ (C-Cl) = + 413 + (-346) = (+) 67 (kJ mol^{-1}) **(1)** Correct answer with no working **(1)** *NOTE* Both values correct scores **(3)** One of the two values correct scores **(2)** *NOTE* Neither value is correct, but a clear statement that ΔH = bonds broken + bonds made scores **(1)**	(+)19 scores **(0)** for this mark -67 scores **(0)** for this mark	**3**

Question Number	Acceptable Answers	Reject	Mark
24(e)(ii)	Step A as (ΔH) is **negative/exothermic** (compared with a positive/endothermic value for Step B) OR Step A as it is the more energetically favourable **Mark CQ on the energy changes in (e)(i)** e.g if +19 and -67 given in (e)(i), Step B will be justified for the CQ mark; e.g. if both values endothermic, selects the less endothermic value OR if both values exothermic, selects the more exothermic value *IGNORE* statements such as "no harmful by-products" etc.		**1**

Question Number	Acceptable Answers	Reject	Mark
24(f)	Volume of bromomethane = $\frac{5}{1\,000\,000} \times 2.5 \times 10^5$ = 1.25 (dm^3) Correct answer with no working scores the mark		**1**