Mark Scheme (Results)

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GCE

GCE Chemistry (6241) Paper 1

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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.

Using the mark scheme

1. / means that the responses are alternatives and either answer should receive full credit.
2. ( ) 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.
3. [ ] words inside square brackets are instructions or guidance for examiners.
4. Phrases/words in bold indicate that the meaning of the phrase or the actual word is essential to the answer.
5. 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.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)(i)	Copper …….$3d^{10}4s^1$	Subscripts/ignore capitals 4s inside 3d	$3d^94s^2$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)(ii)	Bromide ion …….$3d^{10}4s^24p^6$	Subscript/ignore capitals 4s inside 3d	4p inside 3d	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	The **average mass** (taking into account the abundance of each isotope) of the **atoms** (of that element) **(1)** relative to 1/12th the (mass of a) carbon 12 atom Or relative to ^{12}C = 12 (exactly) **(1)** *second mark stand alone*	Weighted/mean in place of average Atoms must be mentioned at least once to score **(2)** Average mass of a mole of atoms of an element relative to 1/12th mole of C^{12} / relative to one mole of ^{12}C = 12 (exactly) **(2)**		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	$\frac{[62.93 \times 69.17] + [64.93 \times 30.83]}{100}$ **(1)** = 63.55 **(1)** must be to 2 decimal places cq only on transcription error e.g. 69.71 provided answer to 2 d.p.	63.54 with some working scores **(1)** Correct answer alone scores **(2)** Answer should have no unit, but allow unit of "g mol^{-1}" but **not** "grams" or "g"		2

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>1.(d)(i)</td><td>
<table>
<tr><td>Cu</td><td>C</td><td>O</td><td>H</td></tr>
<tr><td>$\frac{57.5}{63.5}$</td><td>$\frac{5.40}{12}$</td><td>$\frac{36.2}{16}$</td><td>$\frac{0.900}{1}$</td></tr>
<tr><td>0.906</td><td>0.450</td><td>2.26</td><td>0.900</td></tr>
<tr><td>2.01</td><td>1</td><td>5.02</td><td>2.00</td></tr>
</table>
Empirical formula $Cu_2CO_5H_2$
(1) for dividing by atomic mass
(1) stating empirical formula</td><td>Correct answer without working scores (2)</td><td>Use of atomic number scores 0</td><td>2</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)(ii)	Empirical formula mass = 221 = M_r Molecular formula $Cu_2CO_5H_2$ *Must show use of 221*	If use atomic number in(i) allow mark for Cu_2CO_5H and 220 Allow any formula that adds up to the correct molecular formula		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)	(Highest = $^{65}Cu + 2\ ^{37}Cl$) = 139 **(1)** (Lowest = $^{63}Cu + 2\ ^{35}Cl$) = 133 **(1)** Ignore units			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	Lithium carmine/ red/ magenta/ crimson Any combination of these or prefaced by deep or dark Potassium: lilac Sodium: yellow **All three correct 2 marks** **Two correct 1 mark**	 scarlet mauve or purple orange or yellow-orange	 Brick-red	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	Electrons (absorb heat energy and) are promoted (to higher level) **(1)** They drop back **and** emit light/radiation (of characteristic colour) **(1)**	 'Excited' any phrase that implies **movement** to higher level ignore references to shells, sub-shells, etc.	If answer based on absorption spectra **scores zero** Colour or energy	2

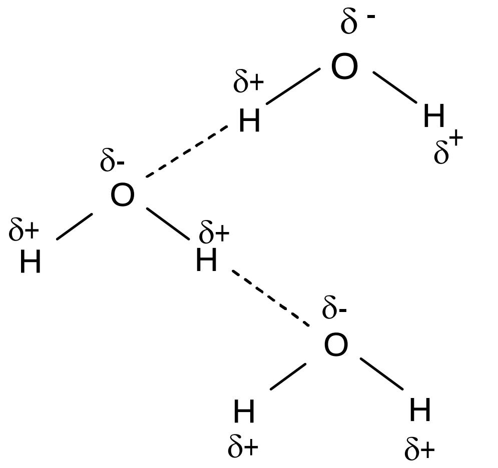
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(i)	$LiCl + H_2SO_4 \rightarrow LiHSO_4 + HCl$ Ignore state symbols	Multiples $2LiCl + H_2SO_4 \rightarrow Li_2SO_4 + 2HCl$		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(ii)	$K_2CO_3 + 2HNO_3 \rightarrow 2KNO_3 + H_2O + CO_2$ $CO_3^{2-} + 2H^+ \rightarrow H_2O + CO_2$ / H_2CO_3 $CO_3^{2-} + H^+ \rightarrow HCO_3^-$ Ignore state symbols and spectator ions	Multiples $K_2CO_3 + 2HNO_3 \rightarrow 2KNO_3 + H_2CO_3$ $K_2CO_3 + HNO_3 \rightarrow KNO_3 + KHCO_3$		1

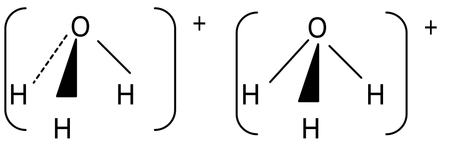
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(iii)	$NaI + AgNO_3 \rightarrow AgI + NaNO_3$ Ignore state symbols and spectator ions	Multiples $Ag^+ + I^- \rightarrow AgI$		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)(i)	The beryllium ion would be (very) small **(1)** and would polarise chloride **ions** (producing sharing of electrons / covalency) **(1)** OR Difference in electronegativity small /similar (1) Therefore **share** (pair of) electrons / no electron transfer (1) *If both routes given. Mark both out of 2 and then score higher hark.*	Allow Be^{2+} has a large charge to size ratio/large charge density Distort for polarise Anion for chloride ion	Answers that refer to polarisation of atoms score zero Answers that refer to electronegativity of ions score zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)(ii)	.. .. :Cl : Be: Cl: .. .. Ignore shape and inner electrons if correct	All dots or all crosses or mixture of both Polymer with continuation bonds	Dimer Ionic formula	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)	• Diagram showing correct covalent and hydrogen bonds **(1)** • Linear around at least two H and water shown as 'v' shaped **(1)** • δ^+ H and δ^- *O* **(1)** must be shown across at least one hydrogen bond 	If only two water molecules shown max 2 marks Blobs for O and H provided correct δ^+/δ^- shown Ignore a slip in partial charges provided not part of hydrogen bond	If use O_2H allow third mark only If any H bond shown between two oxygens or two hydrogens	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)	Each water can form **more** hydrogen bonds (than each hydrogen fluoride molecule) **(1)** So more energy is needed to break the hydrogen bonds in water/separate molecules (hence higher boiling temperature) **(1)** 2nd mark is stand alone unless wrong intermolecular force identified in first part e.g. vdw	Each water molecule can form two hydrogen bonds, HF can only form one Each water molecule can form four hydrogen bonds HF can only form two "Intermolecular force" for "hydrogen bond"	Just 'H bonds in water are stronger' Is not good enough to score the mark Any reference to breaking covalent bonds/bonds in the molecule scores zero.	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)(i)	 Must attempt to draw as a pyramid – wedge or dash or both. If three lines drawn must not look planar Ignore name unless "planar"	Ignore omission of + sign in diagram		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)(ii)	Any number from 105 to 108 inclusive. Mark independently of (c)(i)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)(iii)	Repulsion between the H_3O^+ and the H^+	They are both cations so repulsion OR They are both positive so repulsion		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)	Substance that can lower/reduce the oxidation number (of an element in another substance) Ignore references to loss or gain of electrons unless contradictory.	Substance containing an element whose oxidation number is increased (in a reaction) OR Causes a decrease in the oxidation number of the molecule/species it reacts with OR The reducing agent's oxidation number increases	The oxidation number goes down A definition of redox	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)(i)	$2ClO^{-} + 4H^{+} + 2e^{(-)} \rightarrow Cl_2 + 2H_2O$ Ignore state symbols and $\rightleftharpoons$	Or multiples "$-2e^{(-)}$" on RHS		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)(ii)	$2Cl^{-} \rightarrow Cl_2 + 2e^{(-)}$ Ignore state symbols and $\rightleftharpoons$	Or multiples "$-2e^{(-)}$" on LHS		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)	$ClO^{-} + Cl^{-} + 2H^{+} \rightarrow Cl_2 + H_2O$ Stand alone not consequential on (b) Ignore state symbols and $\rightleftharpoons$	Or multiples		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(d)	White/misty/steamy fumes Mauve/purple/violet/ (iodine) vapour/gas/fumes Black solid **Any two of above** Ignore any yellow solid/ bubbling/fizzing Ignore non-visible observations e.g. getting hot	 lilac (shiny) grey solid	White smoke Just 'dark solid' precipitate	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(e)(i)	$2KClO_3 \rightarrow 2KCl + 3O_2$	Or multiples		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(e)(ii)	Oxidation numbers all correct **(1)** Cl O Start +5 -2 End -1 0 Chlorine reduced as oxidation number decreases/ changes from +5 to -1 **(1)** Oxygen oxidised as oxidation number increases/changes from -2 to 0 **(1)** Oxidation number mark may be awarded if included within explanations. Penalise omission of reference to oxidation or reduction once 2nd and 3rd marks are consequential on stated oxidation numbers.	 Allow 5+, 2-, 1- Allow V, -II, -I Correct identification of O as oxidised and Cl as reduced scores **(2)** provided oxidation number change is in the correct direction for both even if actual numbers wrong.	 Cl^{5+} , Cl^{-1} , O^{-2}	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(i)	The ability of an atom/element/ species to attract the electrons **(1)** in a covalent bond/bond pair/shared electrons **(1)**	"Power/extent" instead of "ability" "pulls toward/draws" instead of "attract"	Molecule	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(ii)	The molecule is symmetrical / tetrahedral **(1)** So bond polarity/dipoles cancels OR centres of positive and negative charge coincide **(1) - stand alone**	Diagrams showing vectors	Too small a difference in electronegativity Charge cancels	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(iii)	Dispersion/Induced dipole /London OR temporary/instantaneous dipole	van der Waals/vdw	Dipole-dipole Hydrogen bond	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)(i)	Ignore sig. figs UNLESS rounded to 1SF 700 g TMP = $\frac{700}{114}$ **(1)** = 6.14 mol Moles of oxygen = 12.5 x 6.14 **(1)** = 76.75 Volume of oxygen = 12.5 x 6.14 x 24 =1842 dm^3 **(1)** Units essential Working must be checked i.e. 3.07 x 25 x 24 = 1842 dm^3 (**2**) 3.07 x 12.5 x 24 = 921 dm^3 (**1**) OR 228 g of TMP need 25 x 24 dm^3 of oxygen **(1)** ∴ 700 g of TMP need $\frac{25 \times 24 \times 700}{228}$ of oxygen**(1)** = 1842 dm^3**(1)** Units essential [Working must be checked]	1840/1800 dm^3 1830 if 6.14 rounded to 6.1	Moles $2C_8H_{18}$ = $\frac{700}{228}$ = 3.07	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)(ii)	Ignore sig. figs UNLESS rounded to 1SF Moles of CO_2 = 8 x6.14 **(1) =** 49.12 Mass of CO_2 = 8 x6.14 x44 = 2161 g **(1)** Units essential but don't penalise if already penalised in (i) OR 228 g of TMP give 44 x 16 g CO_2 **(1)** ∴ 700g of TMP give $\frac{44 \times 16 \times 700}{228}$ g of CO_2 = 2161 g **(1)** Could be consequential on (i)	2160/2200 or 2147 / 2150 / 2100 if 6.14 rounded to 6.1		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(a)	Energy/Enthalpy/heat change **per mole** for the **(1)** Removal of **one electron** (per atom) **(1)** From 1 mole of **gaseous atoms (1)** If wrong equation given with a correct definition **(max 2)**	"Required" instead of "change" $X(g) \rightarrow X^{+}(g) + e^{(-)}$ can score last 2 marks		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)	Increase in shielding/screening **(1)** Increase in nuclear charge/more protons/atomic number **(1)** Increase in distance (of outermost electron)/larger atomic radius OR (increase in) shielding outweighs nuclear charge (increase) **(1)** Ignore references to: effective nuclear charge OR nuclear attraction	Electron at higher energy level		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(c)(i)	Na:Mg:Al metallic (structure) Si giant atomic (structure) P:S:Cl:Ar simple molecular **All three correct 1 mark**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(c)(ii)	strong covalent bonds **(1)** (throughout the lattice and lots of energy) need to break **many** bonds **(1)**			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(c)(iii)	Aluminium supplies more electrons (per atom)/Al ion is more highly charged/Al ion is smaller/ Al ion has a higher charge density **(1)** The (attractive) forces between the aluminium ions and the electrons are stronger/require more energy to break than in the case of sodium. **(1)**	Reverse for Na	Any reference to bonding **other than** metallic bond/ sea of electrons/ delocalised system	2