Cambridge
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AS & A Level

**Cambridge Assessment International Education**
Cambridge International Advanced Subsidiary and Advanced Level

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**CHEMISTRY** **9701/42**
Paper 4 A Level Structured Questions **October/November 2019**
MARK SCHEME
Maximum Mark: 100

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Cambridge Assessment International Education

## Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

| Question | Answer | Marks |
|---|---|---|
| 1(a) | Platinum **and** platinum | **1** |
| 1(b)(i) | **M1:** Nernst quoted correctly<br>$E = E^\ominus + 0.0590 / z\log [ox] / [red]$ or $E = 1.49 + 0.0590\log 5$<br>**M2:** (+)1.53 V minimum 2 sig. fig.<br>Correct answer scores 2 marks | **2** |
| 1(b)(ii) | + / – 0.46 minimum 2 sig. fig. | **1** |
| 1(b)(iii) | **M1:** $Mn^{3+} + 2Br^- \rightarrow Mn^{2+} + Br_2$<br>**M2:** $2Mn^{3+} + 2Br^- \rightarrow Mn^{2+} + Br_2$ | **2** |
| 1(c) | **M1:** 16200 C<br>**M2:** $1.0125 \times 10^{23}$ electrons (use of $1.60 \times 10^{-19}$)<br>**M3:** 0.0802 moles of copper (use of 5.09 and 63.5)<br>**M4:** 0.1603 moles electrons<br>**M5:** $L = 6.32 \times 10^{23}$ (correct answer [5]<br>other approaches acceptable including:<br>**M1:** 16200 C<br>**M2:** $1.0125 \times 10^{23}$ electrons (use of $1.60 \times 10^{-19}$)<br>**M3:** $5.0625 \times 10^{22}$ copper atoms<br>**M4:** 0.0802 moles of copper (use of 5.09 and 63.5)<br>**M5:** $L = 6.32 \times 10^{23}$ (correct answer [5]) | **5** |
| 1(d) | **M1:** $Mg^{2+} + 2e^- \rightleftharpoons Mg$ $E^\ominus = -2.38$ **and** $2H^+ + 2e^- \rightleftharpoons H_2$ $E^\ominus = 0.00$<br>**M2:** hydrogen produced instead / hydrogen easier to reduce / hydrogen preferentially reduced / hydrogen has more positive $E^\ominus$ | **2** |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | **M1:** the time taken for the amount/concentration or a reactant to halve<br>**M2:** the slowest step | **2** |
| 2(b) | • Use an excess of $CH_3Br$<br>• (Several experiments with) different initial [OH]<br>• control / equilibrate temperatures<br>• measure time<br>• find $[OH^-]$ by sample and titrate or use of pH probe **or** find $[Br^-]$ by sample and reference to use of $Ag^+$.<br>• processing of results – plot graph of $[OH^-]$ vs rate or evaluate rate is proportional to $[OH^-]$ numerically<br>Alternative approach:<br>• Use an excess of $CH_3Br$<br>• One experiment with known initial $[OH^-]$<br>• control / equilibrate temperatures<br>• measure time<br>• find $[OH^-]$ by sample and titrate or use of pH probe **or** find $[Br^-]$ by sample and reference to use of $Ag^+$ and describes how to calculate $[OH^-]$ .<br>• processing of results – plot graph of $[OH^-]$ vs time and look for constant half-life<br>Award 1 mark for each correctly identified point. | **4** |

| Question | Answer | Marks |
|---|---|---|
| 2(c) | **M1:** rate = k[ester][$OH^–$]<br>**M2:** value of k = 0.206<br>**M3:** units $mol^{–1}dm^3s^{–1}$ | **3** |

| Question | Answer | Marks |
|---|---|---|
| 3(a)(i) | $1.3 \times 10^{–5}$ | **1** |
| 3(a)(ii) | **M1:** $K_a$ expression used correctly **and** $K_a = 5.5(3) \times 10^{–10}$<br>**M2:** $pK_a = 9.26$<br>Award 2 marks for correct answer | **2** |
| 3(b)(i) | $NH_3 + H^+ \rightarrow NH_4^+$ | **1** |
| 3(b)(ii) | $NH_4^+ + OH^– \rightarrow NH_3 + H_2O$<br>**or** $H^+ + OH^– \rightarrow H_2O$ **and** reference to expression in Q shifting R | **1** |
| 3(c)(i) | quotes $K_w = 1 \times 10^{–14}$ or $1 \times 10^{–1}$ [$H^+$][$OH^–$]<br>[$H^+$] = $1 \times 10^{–7}$ | **1** |
| 3(c)(ii) | **M1:** [$H^+$] = $2.3 \times 10^{–7}$ (calculator value $2.290867 \times 10^{–7}$) **and** $K_w = [2.3 \times 10^{–7}]^2$<br>**M2:** $K_w = 5.2 \times 10^{–14}$ calculator $5.248074 \times 10^{–14}$<br>Award 2 marks for correct answer | **2** |

| Question | Answer | Marks |
|---|---|---|
| 4(a) | **M1:** correct use of stoichiometry<br>**M2:** answer + 189 | **2** |
| 4(b) | **M1:** States or uses correct form of Gibbs equation<br>$\Delta G = \Delta H - T\Delta S$<br>**M2:** appreciates / includes $\Delta G = 0$ at temperature required<br>**M3:** uses 1000 correctly and answer +624(.339)<br>Award 3 marks for correct answer | **3** |
| 4(c) | negative **and** decrease in number / amount of gas molecules | **1** |

| Question | Answer | Marks |
|---|---|---|
| 5(a) | **M1:** Mg – white **flame and** Sr – red **flame**<br>**M2:** white solid product once | **2** |
| 5(b)(i) | **M1:** $2Ca(s) + O_2(g) \rightarrow 2CaO(s)$<br>$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$<br>all substances, balanced<br>**M2:** all state symbols | **2** |
| 5(b)(ii) | neutralises acid / raises pH | **1** |
| 5(b)(iii) | **M1:** $\Delta H_{lat}$ and $\Delta H_{hyd}$ decrease down group<br>**M2:** $\Delta H_{lat}$ decreases / changes more<br>**M3:** $\Delta H_{sol}$ becomes more exo / more –ve / less endo / less +ve | **3** |

| Question | Answer | Marks |
|---|---|---|
| 5(c) | • no change (for hydroxide) / colourless solution<br>• white (for sulfate)<br>• precipitate (for sulfate)<br><br>Award 1 mark for two points, award 2 marks for all three points | **2** |
| 5(d) | **M1:** stability increases / higher T needed for decompose<br><br>**M2:** larger ionic radius<br><br>**M3:** harder to distort / polarise anion / carbonate ion **or** harder to polarise / weaken C–O or C=O bond. | **3** |

| Question | Answer | Marks |
|---|---|---|
| 6(a) | donates one pair of electrons / forms one coordinate bond | **1** |
| 6(b) | See table below.<br><br>Award 1 mark for each correct observation and formula in a row of the table. | **4** |

| Reagent added to a solution of $CuSO_4(aq)$ | Observations | Formula of the copper(II) compound or complex ion that is formed |
|---|---|---|
| a few drops of dilute ammonia | blue ppt | $Cu(OH)_2$ or $Cu(OH)_2(H_2O)_4$ |
| an excess of dilute ammonia | deep blue solution | $[Cu(NH_3)_4]^{2+}$ or<br>$[Cu(NH_3)_4(H_2O)_2]^{2+}$ |
| an excess of aqueous sodium hydroxide | blue ppt | $Cu(OH)_2$ or $Cu(OH)_2(H_2O)_4$ |
| an excess of conc HC*l* | green-yellow / yellow-green / yellow | $[CuCl_4]^{2-}$ |

| Question | Answer | Marks |
|---|---|---|
| 6(c) | • ligand exchange<br>• magnitude of d-orbital splitting changes / ΔE for d-orbitals changes / energy gap between d-orbitals changes<br>• change in colour / frequency / wavelength of light absorbed<br>• electrons are promoted/excited to higher d<br><br>Award 1 mark for two points, award 2 marks for three points, award 3 marks for all four points | **3** |
| 6(d) | **M1:** $E^⊖$ values 1.36 and 0.77 quoted<br><br>**M2:** $2FeSO_4 + Cl_2 \rightarrow Fe_2(SO_4)_2Cl_2$ or $2Fe^{2+} + Cl_2 \rightarrow 2Fe^{3+} + 2Cl^-$ | **2** |
| 6(e)(i) | $[[FeCl_4]^-] / [[Fe(H_2O)_6]^{3+}][Cl^-]^4$ | **1** |
| 6(e)(ii) | 0.078(125) | **1** |

| Question | Answer | Marks |
|---|---|---|
| 7(a)(i) | • two or more repeat units<br>• correct orientation of groups on all four rings and rings correct<br>• trailing bonds shown<br>• amide links all correct<br><br>Award 1 mark for two points, award 2 marks for all four points | **2** |
| 7(a)(ii) | polyamide and condensation | **1** |
| 7(a)(iii) | yes **and** can be hydrolysed | **1** |
| 7(a)(iv) | $PCl_3$ or $PCl_5$ or $SOCl_2$ | **1** |
| 7(a)(v) | **M1:** conc nitric acid + conc sulfuric acid<br><br>**M2:** Sn + HC$l$ | **2** |

| Question | Answer | Marks |
|---|---|---|
| 7(b)(i) | **M1:** sequence / order of amino acids<br>**M2:** $\alpha$-helix **or** $\beta$-sheet<br>**M3:** folding of chain **or** 3-D shape | **3** |
| 7(b)(ii) | covalent bonds / peptide bonds / amide bonds | **1** |
| 7(b)(iii) | **M1:** hydrogen bonds<br>**M2:** between C=O and N–H | **2** |

| Question | Answer | Marks |
|---|---|---|
| 8(a) | bromine / $Br_2$ **and** uv / light / heat | **1** |
| 8(b) | 1,1-dibromoethane | **1** |
| 8(c) | $NCCH_2CH_2CN$ / $CH_2CNCH_2CN$ | **1** |
| 8(d) | **M1:** KCN / NaCN / $CN^-$<br>**M2:** boil/heat/reflux **and** ethanol as solvent | **2** |
| 8(e)(i) | acidified manganate(VII) or dichromate(VI) | **1** |
| 8(e)(ii) | carbon dioxide and water | **1** |

| **Question** | **Answer** | **Marks** |
|---|---|---|
| 8(f) | **M1:** most acidic: hexanoic acid > phenol > hexan-1-ol :least acidic<br>• the other O atom in $CO_2H$ group of hexanoic acid **either**<br>– withdraws charge from OH group **or** is electronegative **and** weakens O–H bond **or**<br>– stabilises resultant anion/negative ion / $–CO_2^-$ group/carboxylate ion<br>• benzene / aromatic / $C_6H_5$ ring in phenol <u>delocalises</u> **either**<br>– lone pair on O atom **and** weakens O–H bond **or**<br>– lone pair on resultant anion/negative ion / phenoxide ion this stabilises resultant anion negative ion / $–CO_2^-$ group/carboxylate ion<br>• the alkyl group in hexan-1-ol donates electrons this strengthens O–H bond<br>Award 1 mark for each bullet point identified. | **3** |
| 8(g)(i) | **M1:** $\delta$12.7 is COOH<br>**M2:** $\delta$3.3 is CH **and** $\delta$1.1 is $CH_3$ | **2** |
| 8(g)(ii) | quadruplet / quartet<br>3 H / protons on neighbouring / adjacent carbon / carbons / C | **1** |
| 8(g)(iii) | 2 (butanedioic acid) and 3 (methylpropanedioic acid) | **1** |

| **Question** | **Answer** | **Marks** |
|---|---|---|
| 9(a)(i) | 10 | **1** |
| 9(a)(ii) | 120 | **1** |
| 9(b)(i) | correct acid chloride | **1** |
| 9(b)(ii) | $NH_3$ or ammonia | **1** |

| Question | Answer | Marks |
|---|---|---|
| 9(c) | **M1:** $(C_5NH_4)COOH$ or $(C_5NH_5)^+COOH$<br>**M2:** $(C_5NH_4)COO^-(Na^+)$ or $(C_5NH_4)COONa$ | **2** |
| 9(d)(i) | $LiAlH_4$ | **1** |
| 9(d)(ii) | **M1:** most basic: X > phenylamine > nicotinamide :least basic<br>**M2:** LP in X cannot be delocalised<br>**M3:** LP in phenylamine delocalised over the benzene ring **or** LP in amide delocalised (more effectively) by C=O | **3** |
| 9(e) | **M1:** M + 1 / M = (1.1 × ?) / 100<br>**M2:** Ans 5.28<br>Award 2 marks for correct answer | **2** |