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**CHEMISTRY**

**9701/42**

Paper 4 A Level Structured Questions

**May/June 2018**

MARK SCHEME

Maximum Mark: 100

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**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2018 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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This document consists of **14** printed pages.

**PUBLISHED****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)      | simple molecular / simple covalent   | 1     |
|           | <b>weak</b> London forces / id-id forces / VDW forces<br><b>or</b> London forces / id-id forces / VDW forces <b>AND</b> small amount of energy to break            | 1     |
| 1(b)(i)   | $\text{SiCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + 4\text{HCl}$<br>or $\text{SiCl}_4 + 4\text{H}_2\text{O} \rightarrow \text{Si(OH)}_4 + 4\text{HCl}$ | 1     |
| 1(b)(ii)  | white solid  | 1     |
|           | steamy fumes / white fumes / misty fumes   | 1     |
| 1(b)(iii) | moles of $\text{SiCl}_4 = 0.8505 / 170.1 = 0.005$  | 1     |
|           | conc of $\text{H}^+ (0.005) \times 4 / 0.8 = 0.025$  | 1     |
|           | $\text{pH} = -\log(0.025) = 1.6$   | 1     |
| 1(c)(i)   | $-225.7 = 239.0 - (18.7 + 2x)$   | 1     |
|           | $x = +223$   | 1     |
| 1(c)(ii)  | decrease in number of <b>moles of gas</b> / more <b>moles of gas</b> on left / reactants (ora)   | 1     |
| 1(d)      | use of $\Delta G = \Delta H - T\Delta S$ with $\Delta G = 0 / \Delta G > 0$ <b>or</b> $T = \Delta H / \Delta S$ or $T = (640\,000 / 225.7)$                        | 1     |
|           | 2836 / 2840 (2835.6)   | 1     |

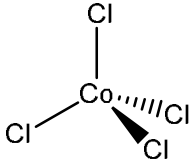
| Question | Answer  | Marks    |
|----------|---|----------|
| 2(a)     | colorimetry / (change) in colour / less light transmission / measure absorbance   | <b>1</b> |
| 2(b)     | Exp 1 and 2: rate $\times$ 1.75 and $[H_2] \times 1.75$ (when $[ICl]$ no change)<br><b>or</b> calculation e.g.: order = $(0.007 / 0.004) / (1.75 / 1.00) = 1$<br><br><b>or</b> Exp 1 and 3: rate $\times$ 2.5 and $[H_2] \times 2.5$ (when $[ICl]$ no change)<br><b>or</b> Exp 2 and 3: rate $\times 10 / 7(1.43)$ and $[H_2] \times 10 / 7(1.43)$ (when $[ICl]$ no change) | <b>1</b> |
| 2(c)     | Exp 4 and 5: rate $\times$ 1.4 and $[ICl] \times 1.4$ (when $[H_2]$ no change)<br><b>or</b> calculation   | <b>1</b> |
| 2(d)     | (rate=) $k[ICl][H_2]$   | <b>1</b> |
| 2(e)     | 62 500 <b>or</b> $6.25 \times 10^4$   | <b>1</b> |
| 2(f)     | $ICl + H_2 \rightarrow HCl + HI$<br><b>or</b> $ICl + H_2 \rightarrow IClH_2$<br><b>or</b> $ICl + H_2 \rightarrow \frac{1}{2}I_2 + ClH_2$  | <b>1</b> |
|          | $HI + ICl \rightarrow HCl + I_2$<br><b>or</b> $IClH_2 + ICl \rightarrow 2HCl + I_2$<br><b>or</b> $ClH_2 + ICl \rightarrow 2HCl + \frac{1}{2}I_2$  | <b>1</b> |

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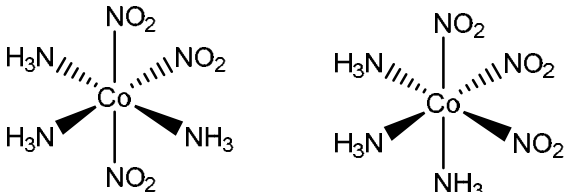
| Question | Answer  | Marks    |
|----------|---|----------|
| 2(g)(i)  | part mark 1: plot a graph of concentration of $[H_2]$ against time<br>part mark 2: constant half-life (showing it is 1st order)<br>part mark 3: draw tangent <b>AND</b> determine gradient (on conc vs time graph) <b>or</b> draw two tangents to determine two gradients (rate) (on conc vs time graph)<br>part mark 4: if conc 1 (at time 1) / conc 2 (at time 2) = gradient 1 / gradient 2<br>part mark 5: plot a graph of rate against concentration of $[H_2]$<br>part mark 6: gives a straight-line through the origin of graph for part mark 5<br><br>2 parts = 1 mark<br>3 parts = 2 marks<br>4 parts = 3 marks | <b>3</b> |
| 2(g)(ii) | [IC $\ddot{I}$ ] doesn't change <b>or</b> [IC $\ddot{I}$ ] only changes slightly  | <b>1</b> |
| 2(h)     | provides an alternative route of lower activation energy / $E_a$<br><b>or</b> to lower $E_a$ and more molecules with $E \geq E_a$   | <b>1</b> |

| Question                      | Answer   | Marks                           |       |         |           |                               |                                 |                               |                               |                    |                             |                                  |                                 |          |
|-------------------------------|--|---------------------------------|-------|---------|-----------|-------------------------------|---------------------------------|-------------------------------|-------------------------------|--------------------|-----------------------------|----------------------------------|---------------------------------|----------|
| 3(a)                          | <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;"></td> <td style="width: 30%;">anode</td> <td style="width: 30%;">cathode</td> </tr> <tr> <td>NaOH (aq)</td> <td><b>oxygen / O<sub>2</sub></b></td> <td><b>hydrogen / H<sub>2</sub></b></td> </tr> <tr> <td>dilute CuCl<sub>2</sub> (aq)</td> <td><b>oxygen / O<sub>2</sub></b></td> <td><b>copper / Cu</b></td> </tr> <tr> <td>conc MgCl<sub>2</sub> (aq)</td> <td><b>chlorine / Cl<sub>2</sub></b></td> <td><b>hydrogen / H<sub>2</sub></b></td> </tr> </table> |                                 | anode | cathode | NaOH (aq) | <b>oxygen / O<sub>2</sub></b> | <b>hydrogen / H<sub>2</sub></b> | dilute CuCl <sub>2</sub> (aq) | <b>oxygen / O<sub>2</sub></b> | <b>copper / Cu</b> | conc MgCl <sub>2</sub> (aq) | <b>chlorine / Cl<sub>2</sub></b> | <b>hydrogen / H<sub>2</sub></b> | <b>3</b> |
|                               | anode  | cathode                         |       |         |           |                               |                                 |                               |                               |                    |                             |                                  |                                 |          |
| NaOH (aq)                     | <b>oxygen / O<sub>2</sub></b>  | <b>hydrogen / H<sub>2</sub></b> |       |         |           |                               |                                 |                               |                               |                    |                             |                                  |                                 |          |
| dilute CuCl <sub>2</sub> (aq) | <b>oxygen / O<sub>2</sub></b>  | <b>copper / Cu</b>              |       |         |           |                               |                                 |                               |                               |                    |                             |                                  |                                 |          |
| conc MgCl <sub>2</sub> (aq)   | <b>chlorine / Cl<sub>2</sub></b>   | <b>hydrogen / H<sub>2</sub></b> |       |         |           |                               |                                 |                               |                               |                    |                             |                                  |                                 |          |
| 3(b)(i)                       | $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}^-$ or $2\text{Br}^- - 2\text{e}^- \rightarrow \text{Br}_2$   | <b>1</b>                        |       |         |           |                               |                                 |                               |                               |                    |                             |                                  |                                 |          |
|                               | $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$   | <b>1</b>                        |       |         |           |                               |                                 |                               |                               |                    |                             |                                  |                                 |          |
|                               | Zinc / Zn <sup>2+</sup> reduced <b>and</b> Br <sup>-</sup> / bromide oxidised  | <b>1</b>                        |       |         |           |                               |                                 |                               |                               |                    |                             |                                  |                                 |          |
| 3(b)(ii)                      | liquid / molten metal<br><b>or</b> orange- <b>brown</b> / reddish <b>brown</b> vapour / gas (at anode)<br><b>or</b> amount of melt / electrolyte decreases   | <b>1</b>                        |       |         |           |                               |                                 |                               |                               |                    |                             |                                  |                                 |          |
| 3(c)                          | <ul style="list-style-type: none"> <li>• <math>50 \times 60 \times 1.2</math> <b>or</b> 3600 C (calculation of number of Coulombs)</li> <li>• <math>3600 / 96\,500</math> <b>or</b> 0.0373 F (calculation of number of Faradays)</li> <li>• <math>0.0373 \text{ F} / 2</math> <b>or</b> 0.01865 / 0.0187 mol H<sub>2</sub> (use of stoichiometry)</li> <li>• <math>0.01865 \times 24\,000 = \mathbf{448-449}</math> (Use of 24 000 &amp; answer to 3sf)</li> </ul> 2 points = 1 mark<br>3 points = 2 marks<br>4 points = 3 marks                                 | <b>3</b>                        |       |         |           |                               |                                 |                               |                               |                    |                             |                                  |                                 |          |

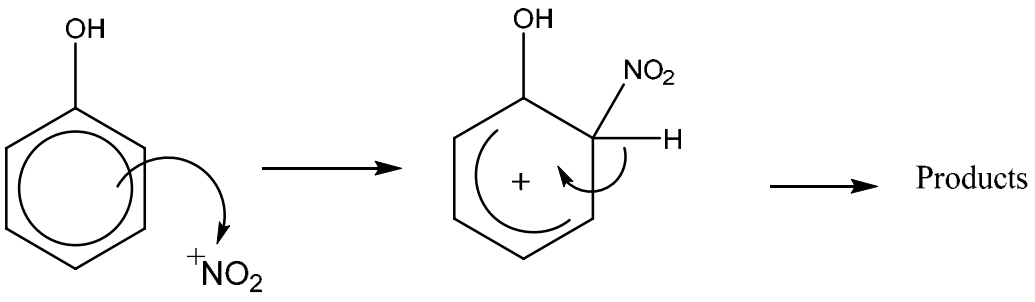
| Question | Answer  | Marks |
|----------|---|-------|
| 4(a)(i)  | $2\text{Ca}(\text{NO}_3)_2 \rightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$                             | 1     |
|          | correct state symbols: (s), (s), (g), (g)   | 1     |
| 4(a)(ii) | brown gas / fumes / vapour  | 1     |
|          | white solid / residue (stays the same)  | 1     |
| 4(b)     | solubility <b>decreases</b> (down the group)  | 1     |
|          | $\Delta H_{\text{latt}}$ and $\Delta H_{\text{hyd}}$ decrease / both become less exothermic / less negative | 1     |
|          | $\Delta H_{\text{latt}}$ decreases / becomes less exothermic by a smaller extent <b>ora</b>                 | 1     |
|          | $\Delta H_{\text{sol}}$ becomes less exothermic / less negative <b>ora</b>                                  | 1     |

| Question | Answer  | Marks |
|----------|---|-------|
| 5(a)     | $3s^2 3p^6 3d^7 4s^2$ <b>or</b> $3s^2 3p^6 4s^2 3d^7$   | 1     |
|          | $3s^2 3p^6 3d^7$  | 1     |
| 5(b)(i)  | An ion formed by a central metal atom / ion surrounded by / bonded to (one or more) ligand(s) | 1     |
| 5(b)(ii) | charge is 2-  | 1     |
|          |            | 1     |

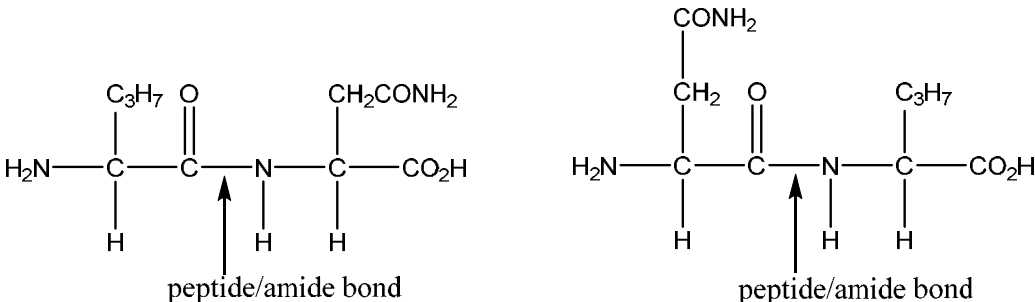
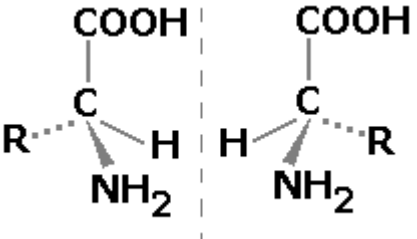


| Question  | Answer   | Marks |
|-----------|--|-------|
| 5(b)(iii) | d-orbitals are split into two groups of orbitals   | 1     |
|           | absorption of light  | 1     |
|           | an electron is excited / (during) electron promotion (to a higher d-orbital)   | 1     |
| 5(b)(iv)  | blue light is not absorbed<br>or absorb (wavelength / frequency of) red and yellow / orange / green<br>or absorbs least in the blue region   | 1     |
| 5(c)      | (blue goes) pink   | 1     |
|           | ligand exchange / ligand substitution  | 1     |
| 5(d)(i)   | $F_2$ or $S_2O_8^{2-}$   | 1     |
| 5(d)(ii)  | +1.05 or +0.19   | 1     |
| 5(d)(iii) | $2Co^{2+} + F_2 \rightarrow 2Co^{3+} + 2F^-$<br>or $2Co^{2+} + S_2O_8^{2-} \rightarrow 2Co^{3+} + 2SO_4^{2-}$  | 1     |
| 5(e)      |  <p>trans 3D diagram – two <math>O_2N-Co-NO_2</math> bond angles are <math>90^\circ</math> and the other is <math>180^\circ</math></p> | 1     |
|           | cis 3D diagram – three $O_2N-Co-NO_2$ bond angles are $90^\circ$ to each other   | 1     |
|           | cis-trans / geometric(al)  | 1     |

| Question | Answer   | Marks    |
|----------|--|----------|
| 6(a)     | <u>any two from</u><br>K / potassium or KOH / potassium hydroxide or K <sub>2</sub> O / potassium oxide  | <b>2</b> |
|          | correct products: (K) hydrogen, (KOH) water, (K <sub>2</sub> O) water  | <b>1</b> |
| 6(b)(i)  | bond circled between N = N   | <b>1</b> |
| 6(b)(ii) | phenylamine <b>and</b> HNO <sub>2</sub>  | <b>1</b> |
|          | T=10 °C or below <b>and</b><br>diazonium ion / salt formed or structure of diazonium ion as [C <sub>6</sub> H <sub>5</sub> N <sub>2</sub> <sup>+</sup> ] | <b>1</b> |
|          | add 2-naphthol in aqueous NaOH / alkali  | <b>1</b> |
| 6(c)(i)  | dilute / aqueous nitric acid / HNO <sub>3</sub> (aq) (at room temp.)   | <b>1</b> |
|          | <u>any two from</u><br>concentrated (acid) needed<br>sulfuric acid / H <sub>2</sub> SO <sub>4</sub> needed<br>higher T needed <b>ora</b>                 | <b>1</b> |
| 6(c)(ii) | p-orbital(s) / lone pair on oxygen / OH group delocalises into / over ring   | <b>1</b> |

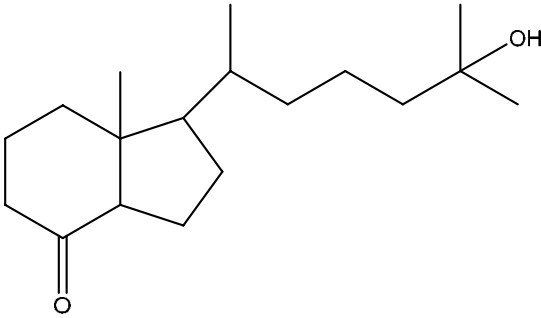
| Question  | Answer   | Marks |
|-----------|--|-------|
| 6(c)(iii) |  |       |
|           | first curly arrow  | 1     |
|           | structure of intermediate  | 1     |
|           | 2nd curly arrow  | 1     |
| 6(c)(iv)  | 4-nitrophenol  | 1     |

| Question | Answer   | Marks |
|----------|--|-------|
| 7(a)     | $C_4H_8N_2O_3$   | 1     |
| 7(b)     | amide, amine, carboxylic acid<br>2 correct = 1 mark<br>3 correct = 2 marks | 2     |

| Question | Answer   | Marks |
|----------|--|-------|
| 7(c)     |                              |       |
|          | peptide / amide bond / unit labelled or circled  | 1     |
|          | (val-asp or asp-val) rest of the dipeptide structure is correct  | 1     |
| 7(d)(i)  | resists change in pH / pH kept within a small range  | 1     |
|          | when small amount of acid or alkali / base is added  | 1     |
| 7(d)(ii) | $\text{H}_2\text{NCHRCO}_2\text{H} + \text{H}^+ \rightarrow \text{H}_3\text{N}^+\text{CHRCO}_2\text{H}$        | 1     |
|          | $\text{H}_2\text{NCHRCO}_2\text{H} + \text{OH}^- \rightarrow \text{H}_2\text{NCHRCO}_2^- + \text{H}_2\text{O}$ | 1     |
| 7(e)     |  <p>each structure [1]</p>   | 2     |

| Question | Answer  | Marks    |
|----------|---|----------|
| 7(f)     | $\text{H}_2\text{NCH}(\text{CH}_2\text{CONH}_2)\text{CO}_2\text{H} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{NCH}(\text{CH}_2\text{CO}_2\text{H})\text{CO}_2\text{H} + \text{NH}_3$ scores<br><b>or</b><br>$\text{H}_2\text{NCH}(\text{CH}_2\text{CONH}_2)\text{CO}_2\text{H} + \text{H}_2\text{O} + 2\text{H}^+ \rightarrow \text{H}_3\text{N}^+\text{CH}(\text{CH}_2\text{CO}_2\text{H})\text{CO}_2\text{H} + \text{NH}_4^+$ | <b>2</b> |

| Question  | Answer   | Marks    |
|-----------|--|----------|
| 8(a)      | 0, 2, 1  | <b>1</b> |
| 8(b)      | 6  | <b>1</b> |
| 8(c)      | 4  | <b>1</b> |
| 8(d)(i)   | 4  | <b>1</b> |
| 8(d)(ii)  | range $\delta$ 25–5                                      | <b>1</b> |
|           | range $\delta$ 190–220                                   | <b>1</b> |
|           | one peak in first range and three peaks in second range  | <b>1</b> |
| 8(d)(iii) | 1  | <b>1</b> |
| 8(d)(iv)  | singlet  | <b>1</b> |
|           | neighbouring / adjacent (carbon) atom has no protons / H | <b>1</b> |
| 8(e)(i)   | CO <sub>2</sub>  | <b>1</b> |
|           | (further) oxidation / oxidative cleavage                 | <b>1</b> |

| Question | Answer   | Marks |
|----------|--|-------|
| 8(e)(ii) |  <p>The chemical structure shows a six-membered ring (cyclohexane) with a ketone group (=O) at the 3-position. A methyl group is attached to the 2-position of the ring. A pentyl chain is attached to the 1-position of the ring. The pentyl chain has a methyl group at the 2-position and a tert-butyl group at the 5-position. The tert-butyl group consists of a central carbon atom bonded to three methyl groups and a hydroxyl group (-OH).</p> | 1     |