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# Mark Scheme (Results)
# Summer 2007

GCE

## GCE Chemistry Nuffield (6256) Paper 01

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**General Guidance on Marking**

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.

Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the mark scheme

The mark scheme gives you:

- 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.

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.

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.

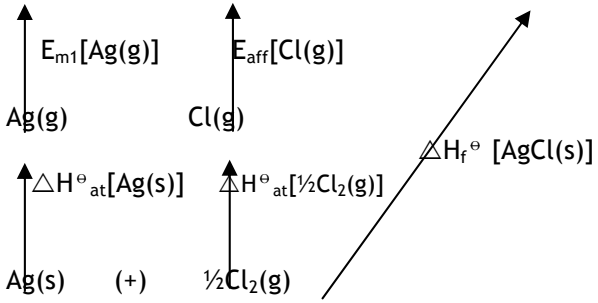
**Quality of Written Communication**

Questions which involve the writing of continuous prose will expect candidates to:

- show clarity of expression
- construct and present coherent arguments
- demonstrate an effective use of grammar, punctuation and spelling.

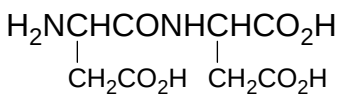
Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC*) in the mark scheme BUT this does not preclude others.

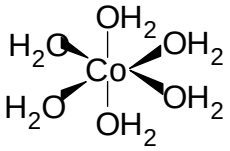
| | EXPECTED ANSWER | | | ACCEPT | REJECT | MARK |
|---|---|---|---|---|---|---|
| 1. | (a) | (i) | $Ag^+(g)$ (+) $Cl^-(g)$ → $AgCl(s)$<br>  <br><br>Entities with state symbols in a correct balanced cycle (Ag(g) and Cl(g) can be omitted) arrows correct **(1)**<br><br>LE = -127.1 – [284.6 + 731 (+)121.7 (+) (-348.8)]<br>OR<br>LE = $\triangle H_f^\ominus$ [AgCl(s)] – {$\Delta H_{at}^\ominus$ [Ag(s)] + $\Delta H_{at}^\ominus$ [½$Cl_2$(g)] + $E_{m1}$[Ag(g)] + $E_{aff1}$[Cl(g)]}<br>**(1)**<br><br>= -916 kJ $mol^{-1}$ value, sign, unit, SF **(1)** | Allow mark for simple triangle (without Ag(g) and Cl(g))<br><br>Answers based on:-<br>$\triangle H_{at}^\ominus$ [½ $Cl_2$(g)]= +122<br>and/or $E_{aff}$ [$Cl_2$(g)]= +349<br>(SB values) | | **(3)** |

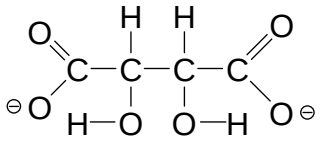
| | EXPECTED ANSWER | | | ACCEPT | REJECT | MARK |
|---|---|---|---|---|---|---|
| | (b) | (i) | (-(-127.1) + 105.6 - 167.2 =) (+) 65.5 (kJ $mol^{-1}$ ) | | | **(1)** |
| | | | (-$\Delta H$/T = - 65500/298 =) -219.8/220 (J $K^{-1}$ $mol^{-1}$ ) **(1)**<br>Be careful to allow TE from first part but sign must be consistent | -0.2198/-0.220 (kJ $K^{-1}$ $mol^{-1}$) | | **(1)** |
| | | (ii) | (72.7 + 56.5 – 96.2 =) (+) 33 ( J $K^{-1}$ $mol^{-1}$) | | | **(1)** |
| Q<br>W<br>C* | | (iii) | -187 (J $K^{-1}$ $mol^{-1}$) - value & sign<br><br>The reaction is an equilibrium which favours the reactants/AgCl only slightly soluble/not soluble<br><br>ALLOW a TE for the comment on their result provided equilibrium aspect is mentioned eg +200 or greater value 'reaction goes to completion'<br><br>If value -200 or more negative ALLOW "reaction does not go" | TE from parts (i) and/or (ii)<br>Because ΔStotal is **negative** reaction is **not spontaneous** (with TE from (i) and (ii)) | "not feasible" for "not spontaneous" | **(1)** |
| | (c) | (i) | $AgCl + e^{(-)} \rightarrow Ag + Cl^-$<br>State symbols not required | | | **(1)** |
| | | (ii) | Silver wire dipping into a precipitate of silver chloride/wire coated with AgCl… **(1)**<br><br>Under a solution containing chloride ions… **(1)**<br><br>Concentration 1.0 mol $dm^{-3}$ at 298 K **(1)**<br>IGNORE pressure<br><br>Mark independently | | Solution of AgCl | **(3)** |

| | EXPECTED ANSWER | | | ACCEPT | REJECT | MARK |
|---|---|---|---|---|---|---|
| | (d) | (i) | (Pt\|)[Ag(s) + $Cl^-$(aq)] , AgCl(s) :(:) $Cu^{2+}$(aq)\|Cu(s)<br><br>OR (Pt)[Ag(s) + $Cl^-$(aq)] \| AgCl(s) :(:) $Cu^{2+}$(aq)\|Cu(s)<br>Square bracket entities can be reversed<br>Entity sequence ignoring state symbols **(1)**<br>Detail including state symbols **(1)** | + can be replaced by comma or vertical line in silver electrode<br><br>If left hand/right hand electrode reversed<br>(1 max) | | **(2)** |
| | | (ii) | (+0.34) – (+0.22) = + 0.12 V<br>value **(1)**<br>sign, unit **(1)** | Allow TE for x-0.22 to correct internal TE value with sign and unit for **1 max** | +0.34 + 0.22 =+0.56 V **(0)** | **(2)** |
| | | (iii) | Add (+) 0.22 (V to all readings against silver-silver chloride electrode) | | Anything else! | **(1)** |
| | | (iv) | Any reasonable comment about hydrogen or gas<br>e.g. no need for a gas/hydrogen at 1 atm)/ more portable/<br>can be placed in solution containing chloride ions directly / cheaper **as no Pt electrode/no salt bridge** | no pure gas needed | 'Easier to set up' on its own | **(1)** |
| | | | | | | **Total 17 marks** |

| | EXPECTED ANSWER | | | ACCEPT | REJECT | MARK |
|---|---|---|---|---|---|---|
| 2. | (a) | C | | | | **(1)** |
| | (b) | D | | | | **(1)** |
| | (c) | A and B | | | | **(1)** |
| | (d) | (i) | B | | | **(1)** |
| | | (ii) | A | | | **(1)** |
| | | (iii) | Any two of A, B , E | | | **(1)** |
| | | (iv) | Any two of A, C , E | | | **(1)** |
| | | (v) | B and D | | | **(1)** |
| | (e) | (i) | (N-)ethylethanamide | | | **(1)** |
| | | (ii) | $CH_3COCl + CH_3CH_2NH_2 \rightarrow CH_3CONHCH_2CH_3 + HCl$ | $(CH_3CO)_2O$ & product $CH_3CO_2H$<br>$CH_3CO_2H$ & product $H_2O$<br>$CH_3CClO$<br>Fully/ partially displayed formulae | $C_6H_5NH_2$ for ethylamine<br>Omission of other product, HCl,$H_2O$ etc | **(1)** |
| | (f) | (i) | $HO_2CCH_2CH(NH_2)CONHCH(CO_2H)CH_2CO_2H$<br>OR<br>  <br>IGNORE incorrectly attached side chains | Displayed/partially displayed formulae for all parts | CO-H-N/COHN<br>$CONH_2$<br>as incorrect peptide links.<br><br>Reject side chain linkage | **(1)** |
| | | (ii) | $nCH_3CH=CHCH_3 \rightarrow -(CH(CH_3)-CH(CH_3))_n-$ **(1)**<br>Allow two or more repeating units in the polymer<br>Any two from: high T/heat OR high P OR catalyst OR initiator/di(dodecanoyl peroxide) **(1)** | | UV Light/ free radical on own | **(2)** |

| | | EXPECTED ANSWER | ACCEPT | REJECT | MARK |
|---|---|---|---|---|---|
| Q<br>W<br>C* | (g) | **D (1)**<br>Two different/least number of hydrogen/carbon environments/situations **(1)**<br>Mark independently of (i) | IF **D** C-H bonds environment identified | | **(2)** |
| | (h) | **B** | | | **(1)** |
| | (i) | **B** / $CH_3CH_2CHBrCH_3$/ 2(-) bromobutane **(1)**<br>(Equal abundance/existence of two) bromine isotopes **(1)** | | | **(2)** |
| | | | | | **Total 18 marks** |

| | EXPECTED ANSWER | | | ACCEPT | REJECT | MARK |
|---|---|---|---|---|---|---|
| 3. | (a) | $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$ | | $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 (4s^0)$<br>Allow 4s before 3d | | **(1)** |
| | (b) |  <br><br>Bonds must be from O to Co on one RHS water molecule | | Accept recognisable Octahedron OR attempt at octahedron, correctly bonded, with the term octahedral/octahedron | | **(1)** |
| | (c) | (i) | Chloride (ion)/$Cl^-$ | | | **(1)** |
| Q<br>W<br>C* | | (ii) | $Co(H_2O)_6^{2+}(aq) + 4Cl^-(aq) \rightarrow CoCl_4^{2-}(aq) + 6H_2O(l)$<br><br>Sign is positive because **five** entities/molecules/moles go to **seven**<br><br>ALLOW<br>$Co(H_2O)_6^{2+}(aq) + 4HCl(aq) \rightarrow CoCl_4^{2-}(aq) + 6H_2O(l) + 4H^+(aq)$<br>With sign is positive because **five** entities/molecules/moles go to **eleven**<br><br>If wrong equation, allow internal TE for consistent comment providing has entities in the same phase **for 1 max**<br><br>IGNORE other comments | | | **(1)**<br><br>**(1)** |

| | EXPECTED ANSWER | | | ACCEPT | REJECT | MARK |
|---|---|---|---|---|---|---|
| | (d) | (i) | $Co(NH_3)_6^{2+}$ | | | **(1)** |
| Q<br>W<br>C* | | (ii) | (Pink) to green to pink **(1)**<br><br>Ammonia complex (lg) K = 4.39<br>Edta complex (lg) K = 16.3<br>Both required **(1)**<br><br>**Edta** (complex) is more stable/has a higher stability constant **(1)** | | | **(3)** |
| | (e) | (i) | Reactants and catalyst are in the same phase/state/Reactants and catalyst are both aqueous solutions/ in the same solvent | | | **(1)** |
| Q<br>W<br>C* | | (ii) | Hydrogen peroxide **oxidises**/**removes electrons** from $Co^{2+}$ to $Co^{3+}$, **(1)**<br>Then $Co^{3+}$ **oxidises**/**removes electrons** from tartrate ions **(1)**<br>If 'reacts with' used without reference to redox give **1 max**<br>If $Co^{2+}$ going to $Co^{3+}$, then $Co^{3+}$ to $Co^{2+}$ without other reactants give **1max**<br><br>**Exception**<br>**Use your judgement** eg 'partly filled d shell loses and gains an electron' gains **both** marks | | | **(2)** |
| | | (iii) |  <br>Ignore charges | Structural or displayed<br>Protonated carboxylate groups | | **(1)** |
| | | | | | | **Total 13 marks** |

| | EXPECTED ANSWER | | | ACCEPT | REJECT | MARK |
|---|---|---|---|---|---|---|
| 4. | (a) | (i) | Amount of $CO_2$ = $\frac{53}{24000}$ = 0.0022 (mol)<br>Amount of $H_2O$= $\frac{0.020}{18}$ = 0.0011 (mol)<br><br>Amount of C = 0.0022mol = 0.0265(g)<br>Amount of H = 0.0022mol = 0.0022(g)<br><br>Any one of above needed for 1st mark **(1)**<br><br>Mass of O in Z = 0.0714 (g)<br>OR amount of O in Z = 0.0045 (mol)<br>Some clear indication they have done it correctly **(1)**<br><br>Empirical formula $CHO_2$ **(1)** | 0.002 with working | | **(3)** |
| | | (ii) | $(CHO_2)_y$ = (12 + 1 + 2x16)y = 90<br>Y=2<br>Molecular formula $C_2H_2O_4$<br>Allow TE from (i)<br>Allow $C_2H_2O_4$ with no working<br>Allow any indication they know how to do it<br>eg 'n x empirical mass = molar mass' | | $C_4H_{10}O$ only (no connection with (i)) | **(1)** |
| | | (iii) | (0.01 mol **Z** contain $\frac{20.0\times1.00}{1000}$ =) 0.02 (mol) **(1)**<br><br>$CO_2H$<br>\|<br>$CO_2H$ **(1)** | Formula alone for Z<br><br>Fully/partially displayed formula | | **(2)** |

| | EXPECTED ANSWER | | | ACCEPT | REJECT | MARK |
|---|---|---|---|---|---|---|
| | | (iv) | **W** $CH_2=CH_2$ **(1)**<br>**X** $CH_2BrCH_2Br$ **(1)**<br>**Y** $CH_2OHCH_2OH$ **(1)**<br>Look out for TE and internal TE<br>Eg **W** $CH_3CHCH_2$<br>**X** $CH_3CHBr\ CH_3$<br>**Y** $CH_3CHOHCH_3$<br>is worth **1 max** | full credit for consistent answers based on other gaseous alkenes eg $CH_3CHOHCH_2OH$ etc | | **(3)** |
| | | (v) | $C_{20}H_{42} \rightarrow C_{18}H_{38} + C_2H_4$ **(1)**<br>Allow $C_{17}H_{36} + C_3H_6$ OR $C_{16}H_{34} + C_4H_8$ | TE for **W**<br>Any balanced equation including ethane | | **(1)** |
| | (b) | Potassium manganate((VII))/$KMnO_4$ **(1)**<br>Sulphuric acid/$H_2SO_4$ consequential on potassium manganate **(1)**<br>ALLOW 'acidified potassium manganate((VII))' for both marks | | TE for W alkene and corresponding monohydric alcohol<br>1. $H_2SO_4$/sulphuric acid<br>2. $H_2O$/water | Other Roman numerals after managate | **(2)** |
| | | | | | | **Total 12 marks** |