**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

# MARK SCHEME for the May/June 2010 question paper

# for the guidance of teachers

## 9701 CHEMISTRY

**9701/33** Paper 31 (Advanced Practical Skills), maximum raw mark 40

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.

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UNIVERSITY of CAMBRIDGE
International Examinations

**Question 1 Round all thermometer readings to the nearest 0.5°C.**

**Supervisor's Report**
Calculate m/ΔT correct to 3 s.f. for each experiment.

**Candidate's scripts**
Calculate m/ΔT correct to 3 s.f. for each experiment.

| Question | Sections | Indicative material | Mark | |
|---|---|---|---|---|
| **1 (a)** | MMO Collection | **(i)** Follows instructions with regard to times and temperature readings *0–3 minutes at 1 minute intervals;*<br>*5–8 minutes at ½ minute intervals,* ***and*** $\mathbf{T_1}$ *recorded in box. (Ignore if also in table)* | 1 | |
| | PDO Recording | **(ii)** All columns correctly labelled with appropriate unit shown.<br>*Must use solidus, brackets or describe unit fully in words.*<br>*If units not included in column headings every entry must have the correct unit shown*<br>Accept min, mins or minutes | 1 | |
| | | **(iii)** *Look at results here and in* **(d)**.<br>All **balance readings** consistent to at least 1 decimal place.<br>**and**<br>All **thermometer readings** (table and box) recorded to nearest 0.5 °C.<br>There must be at least one at 0.5 in **(a).** | 1 | [3] |

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| Question | Sections | Indicative material | Mark | |
|---|---|---|---|---|
| **(b)** | PDO<br>Layout | **(i)** Temperature of water in the beaker plotted on *y-axis* against time on *x-axis.*<br>Clearly labelled axes (ignore units) *[temp/time are minimum acceptable labels]*<br>*but*<br>*accept* **T / °C** *and* **t / min** *as labels.*<br>*The unit is necessary in this case* | 1 | |
| | | **(ii)** Uniform and sensible scales for candidate's choice of graph.<br>Plotted points must be in at least 4 large squares on the temperature axis and 5 large squares on the time axis.<br>*Do **not** include any plotted value of* $\mathbf{T_1}$. | 1 | |
| | | **(iii)** *There should be a minimum of 5 plotted points between 5 and 8 minutes*.<br>**Examiner then checks plotting of points at $t_{0\ min}$, $t_{5\ min}$ and $t_{8\ min}$ and the plotting of any suspect point.**<br>**If any of the $t_{0\ min}$, $t_{5\ min}$ and $t_{8\ min}$ points is missing check the adjacent point.**<br>*Points should be within ½ of a small square of the correct position and in the correct small square* | 1 | |
| | ACE<br>Interpretation | **(iv)** Acceptable straight lines drawn – *an acceptable straight line is one passing through the majority of points or has balanced points on either side of the line* **and**<br>correct values of $\mathbf{T_2}$ and $\mathbf{T_3}$ read (to within ½ small square) from the graph.<br>*Extrapolation need not be drawn on the graph* | 1 | [4] |
| **(c)** | ACE<br>Interpretation | **(i)** and **(ii)**<br>Award **one mark** if **both** of the following expressions are <u>correctly evaluated</u>.<br>heat gained = 210 × candidate value of ($\boldsymbol{T_3} - \boldsymbol{T_2}$)<br>heat lost = 210 × candidate value of ($\boldsymbol{T_1} - \boldsymbol{T_3}$)<br>*Units should be consistent. Ignore any sign given.* | 1 | |
| | | **(iii)** No mark. | | [1] |

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| Question | Sections | Indicative material | Mark | |
|---|---|---|---|---|
| **(d)** | MMO<br>Quality | **Compare the two m/$\Delta T$ values (g°C$^{-1}$) for the candidate's two experiments.**<br>Award **three** marks for a difference up to **0.2**<br>Award **two** of these three marks for a difference of **0.2+ °C – 0.3**<br>Award **one** of these three marks for a difference of **0.3+ °C – 0.4**<br>**Compare the <u>standard</u> m/$\Delta T$ value of 1.70 g.°C$^{-1}$ with the closer value from the candidate's results.**<br>Award **three** marks for a difference up to **0.2**<br>Award **two** of these three marks for a difference of **0.2+ °C – 0.3**<br>Award **one** of these three marks for a difference of **0.3+ °C – 0.4** | 3<br><br>3 | [6] |
| **(e)** | ACE<br>Interpretation<br>ACE<br>Conclusions | **(i)** Give **one mark** for correct <u>evaluation</u> of **430 × candidate's $\Delta T_{(expt\ 1)}$**<br><br>**(ii)** The candidate explains that the beaker as well as the solution has cooled<br>***Short term*** *– beaker loses heat energy as it cools*<br>***Long term*** *– Heat energy is absorbed by beaker (and solution)*<br>***Read in context – Beware of:***<br>*Heat is absorbed by beaker and surroundings (con)* | 1<br><br>1 | |
| | ACE<br>Interpretation | **(iii)** Give **one mark** if the candidate adds ($\Delta T_{(expt\ 1)}$ **× answer in (c)(iii)**) to the answer in **(e)(i)**.<br>*Correct expression is sufficient, evaluation not required.*<br><br>**(iv)** The candidate <u>correctly</u> calculates the moles of **FA 1** *(candidate's mass / 53.5)* used in expt 1.<br><br>***In (i), (iii) or (iv) withhold one mark for use of data from expt 2 the first time it is seen. Do not withhold more than one mark for this.***<br><br>**(v)** The candidate correctly divides the answer to **(e)(iii)** by the answer to **(e)(iv)** and by 1000.<br>*Ignore errors in evaluation and sign* | 1<br><br>1<br><br><br><br>1 | |
| | ACE<br>Conclusions | **(vi)** Award this mark if the candidate has given a +ve sign **and** explains that:<br>the reaction is endothermic **or** heat is absorbed in the reaction **or** the temperature falls during the reaction. | 1 | |
| | PDO<br>Display | **(vii)** Award this mark if working is shown in sections **(c)(i)**, **or (c)(ii) or (e)(i) <u>and</u> (e)(iv) and (e)(v)**. | 1 | |

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| Question | Sections | Indicative material | Mark | |
|---|---|---|---|---|
| **(e) contd** | PDO Display | **(viii)** Award this mark if the final answer in section **(iii)** of **(c) and** section **(iv)** of **(e)** is given to 2 or 3 significant figures. | 1 | [8] |
| **(f)** | ACE Interpretation | Correctly calculates the difference and the percentage error.<br>*Ignore significant figures.* ***Beware mixed units*** | 1 | [1] |
| **(g)** | ACE Conclusions | Clearly described source of error<br>**(i)** Heat loss / gain<br>**(ii)** Use of glass beaker<br>**(iii)** Precision of thermometer<br>**(iv)** Small temperature fall | 1 | |
| | ACE Improvements | Specific improvement given with some attempt at justification.<br>**(i)** Lid – prevents convection or evaporation<br>Insulation – prevents conduction<br>Use plastic beaker – provides insulation<br>**(ii)** Polystyrene cup – lower heat capacity<br>**(iii)** Use thermometer at 0.5 $^{o}$C or better, gives smaller % error.<br>**(iv)** Larger mass of $NH_4Cl$ or smaller water volume. Gives greater temperature change<br>**Do not award either of these marks for answers referring to use of measurement of volume or measurement of mass.** | 1 | [2] |
| | **Total** | | | **[25]** |

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| Question | Sections | Indicative material | Mark | |
|---|---|---|---|---|
| **FA 2** is $Na_2SO_4(aq)$; **FA 3** is $Na_2CO_3(aq)$; **FA 4** is a mixture of $Na_2SO_4(aq)$ and $Na_2CO_3(aq)$ | | | | |
| **2 (a)** | MMO Decisions | **(i)** **reagent 1** – chooses any **specified acid** to detect the carbonate present *(name or formula* may be in results table)<br>**and**<br>**reagent 2** – chooses $BaCl_2$ or $Ba(NO_3)_2$.<br>*Accept $Ba^2$+(aq) or soln containing $Ba^{2+}$(aq) as reagent.*<br>*Also accept incorrect formulae for a compound, e.g. BaCl, providing the identity of the reagent is obvious.* | 1 | |
| | | **(ii)** Explains significance of order in which reagents added.<br>acid first – to remove carbonate from solution **or** after $Ba^{2+}$ – to dissolve any barium carbonate precipitated.<br>**Candidates must make clear the relationship of acid to barium carbonate.**<br>*Do **not** award this mark if sulfuric acid has been used in* **(i)** | 1 | |
| | | In section **(iii)**, assume reagents follow each other in the same test-tube unless otherwise stated.<br>***Allow lead(II) nitrate as the 2nd reagent providing it is used with nitric acid.*** | | |
| | | **(iii)** **Addition of acid**<br>No reaction with **FA 2**, effervescence/bubbles/bubbling (or gas tested with limewater) for **FA 3 and FA 4** | 1 | |
| | MMO Collection | **Addition of $Ba^{2+}$(aq)**<br>white ppt with all three solutions, if added as first reagent or to a separate sample<br>**or**<br>white ppt, insoluble in acid for **FA 2**, soluble in acid for **FA 3** and insoluble/partially soluble in acid for **FA 4** if added before the addition of acid<br>**or**<br>white ppt with **FA 2** and **FA 4** and no ppt with **FA 3** if added after addition of acid<br>*Do **not** award this mark if sulfuric acid has been used **unless** it has been stated that $Ba^{2+}$(aq) was added to a **fresh sample*** | 1 | |
| | | ***Allow deductions from lead nitrate (as for barium salt) ONLY if nitric acid has been specified. If a candidate selects limewater as a reagent, can get observation marks, $CaSO_4$ soluble at this concentration.*** | | |

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| Question | Sections | Indicative material | Mark | |
|---|---|---|---|---|
| **FA 5** is $CuSO_4(aq)$; **FA 6** is $NH_4Cl(aq)$; **FA 7** is $CoCl_2(aq)$; **FA 8** is $MnSO_4(aq)$ | | | | |
| **(a) contd** | ACE Conclusions | **No ecf to be applied in these conclusions**<br>**(iv)** Give **one mark** for identifying carbonate in **FA 3** and **FA 4**, with supporting evidence.<br>Minimum acceptable evidence – gas with acid **or** white ppt (barium carbonate) soluble in acid<br><br>Give **one mark** for identifying sulfate in **FA 2** and **FA 4 only**, with supporting evidence.<br>Minimum acceptable evidence – white ppt with $Ba^{2+}$ (if insoluble in acid) but **con** if soluble.<br>If no mark has been awarded in **(iii)** or **(iv)**, allow one mark if evidence given is consistent with the ions identified | 1<br><br>1 | [6] |
| **(b)** | MMO Collection | **(i)** For **FA 5**, records<br>blue ppt, insoluble in an excess of NaOH<br>blue ppt with ammonia; soluble **or** <u>forming a deep blue colour</u> with excess of the reagent | 1 | |
| | | **(ii)** For **FA 6**, records<br>no precipitate with both NaOH and $NH_3(aq)$, **and** ammonia detected **or** red litmus turning blue on heating with NaOH<br>*(No reference to a gas is necessary)* | 1 | |
| | MMO Decisions | **(iii)** Describes <u>test carried out on gas evolved</u> to identify ammonia.<br>*An observation of no ppt with either reagent and a gas turning red litmus blue on heating with NaOH would earn both the C3 and the De7 mark.*<br>***If the mark is not awarded for ammonia test a retrospective mark can be given here for testing gas evolved with limewater in* (a)** | 1 | |
| | MMO Collection | **(iv)** For **FA 7** records<br>blue (only) ppt, on initial addition of NaOH<br>blue/green ppt, insoluble in excess ammonia | 1 | |
| | | **(v)** Any reference to pink in either precipitate on initial formation, in excess or on standing. | 1 | |

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| Question | Sections | Indicative material | Mark | |
|---|---|---|---|---|
| **(b) contd** | MMO Collection | **(vi)** For **FA 8**, records<br>off-white/pale brown/buff/beige precipitate insoluble in an excess of NaOH<br>off-white/pale brown/buff/beige precipitate insoluble in an excess of ammonia<br>Do **not** accept a cream ppt.<br><br>**(vii)** Darkening of the initial precipitate<br>**or**<br>appropriate coloured precipitate (allow white or cream ppt here as colour of initial ppt) turning brown at any stage with either reagent. | 1<br><br>1 | [7] |
| **(c)** | ACE Conclusions | **No ecf to be applied in these conclusions**<br>Identifies all cations correctly:<br>**FA 5** is $Cu^{2+}$ / copper(II)<br>**FA 6** is $NH_4^+$ / ammonium<br>**FA 8** is $Mn^{2+}$ / manganese(II)<br><br>Gives appropriate supporting evidence for **two** of the three ions<br>Minimum evidence for each of the ions.<br>**$Cu^{2+}$**<br>**(i)** Blue ppt with both NaOH and $NH_3$(aq), **or**<br>**(ii)** Blue ppt with NaOH, insoluble in excess of the reagent, **or**<br>**(iii)** Blue ppt with $NH_3$(aq), soluble in excess of the reagent, **or**<br>**(iii)** Dark blue colour formed at any stage with $NH_3$(aq)<br>**$NH_4^+$**<br>**(i)** Ammonia, $NH_3$, alkaline gas, or gas turning red litmus blue with NaOH (hot or cold)<br>**$Mn^{2+}$**<br>**(i)** Initial off-white to beige ppt with NaOH and with $NH_3$(aq)<br>**or**<br>**(ii)** Precipitate darkening / turning brown with either reagent – providing the colour of the initial precipitate is not completely inappropriate (e.g. blue or green). | 1<br><br>1 | [2] |
| | **Total** | | | **[15]** |

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