

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
GCE Advanced Subsidiary Level and GCE Advanced Level

**MARK SCHEME for the October/November 2009 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/31

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.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

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| Question | Sections | Indicative material | Mark | |
|---|----------------|--|-------------|------|
| 1 (a) | PDO layout | Two balance readings and mass of FA 1 clearly recorded for each experiment. (Data for 2 nd experiment could be on page 4) <i>Examiner to check subtraction for each experiment – no penalty in this section but see section (e)</i> | 1 | [1] |
| 1 (b) | PDO Recording | If the candidate has only performed one experiment the following points <u>only</u> can be awarded: (ii), (iii), (vi), (vii) and (x). (i) Single table recording observations for both experiments. Times at ½ minute intervals. (ii) Appropriate headings and units <i>Allow times in minutes (min) or seconds</i> (iii) All temps recorded to nearest 0.5 °C (Must be more than one at .5 as well as .0) | 1 1 1 | |
| | MMO Collection | (iv) Some temps recorded before mixing and some after mixing for each expt. or Candidate records initial temperature and at least three temperatures after mixing for each experiment (v) First temperature after mixing is clearly taken 1 minute after adding the zinc powder <i>(Examiner judgement re temperatures recorded before mixing / temperatures only recorded after mixing)</i> and cooling for at least 5 minutes after recorded maximum temperature. | 1 1 | |
| If the candidate performs one experiment only, the following marks may not be awarded: (i) (iv) (viii) & (ix) (xi) | | | | |
| For Supervisor - | | calculate mean maximum ΔT to nearest 0.5 °C; calculate mean of time taken (to nearest ½ min) to reach max temperature after mixing. | | |
| MMO Quality | | (vi) & (vii) 1 st expt. Compare ΔT with Supervisor. award (vi) and (vii) if within 2 °C award (vii) only if >2 °C and $\leq 5^\circ\text{C}$ | 2 2 | [11] |
| | | (viii) & (ix) 2 nd expt. Compare ΔT with Supervisor. award (viii) and (ix) if within 2 °C award (ix) only if >2 °C and $\leq 5^\circ\text{C}$ (x) (1 st expt) & (xi) (2 nd expt). Compare time after mixing at which max temp is obtained with same time for Supervisor, for each expt. If Supervisor ≤ 3 min; 1 mark for Δ time ≤ 1 min. If Supervisor >3 min; 1 mark for Δ time $\leq 1\frac{1}{2}$ min. | 1 1 | |

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| (c) | PDO Layout | Plots temperature on y-axis and time on x-axis and has at least one temperature and one time label (<i>ignore absent or incorrect units</i>) | 1 | |
| | | Scales used are linear and easy for the examiner to use, (3 or 4 min. per large square are acceptable) | 1 | |
| | | Scales should enable the temperature when zinc is added and <u>all</u> points after the addition of zinc to be plotted. <i>Points should be within a minimum of 5 large squares on temperature axis</i> | 1 | |
| A completely horizontal line, drawn at the initial temperature can be accepted as equivalent to plotting of initial temperature. | | If the candidate has recorded temperatures and times before zinc is added: Correctly plots on <u>each</u> graph: the last temperature/time, from results before zinc is added or the temperature and maximum temperature (<i>associated time not required</i>) | | |
| If only one graph has been drawn, the 1 st and 2 nd marks may be awarded and one further mark if the initial and maximum temperatures are correctly plotted and there is an appropriate extrapolation. | | If the candidate has only recorded the initial temperature of the solution: Correctly plots on <u>each</u> graph: the temperature when zinc is added and maximum temperature (<i>associated time not required</i>) Draws a cooling curve or straight line and projects the curve / line back to the time of mixing | 1 | [4] |
| (d) | ACE Interpretation | For experiment 1: Correctly reads the temperature rise from the graph to within 1 °C of the value obtained from the graph by the examiner. If the value is incorrect for experiment 1, check value for experiment 2. Award mark if either value is correct. | 1 | [1] |
| (e)–(h) | PDO Display | Shows working in all sections attempted – <i>minimum of three sections required.</i> Significant figures in <u>final answers</u> . 2 or 3 sf in 1(e), 2 to 4 sf in 1(g), 3 sf only in 1(h) <i>minimum of three sections required.</i> | 1 1 | [2] |
| (e) | ACE Interpretation | Correctly calculates 2.0×10^{-2} mol of CuSO_4 , and $\left(\frac{\text{mass zinc}}{65.4}\right)$ for each experiment. <i>Answers correctly rounded for the number of significant figures displayed.</i> Do not award this mark if there is an error in subtraction or there are missing balance readings in section (a). | 1 | [1] |

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| (f) | ACE Conclusions | To gain this mark the candidate must refer to: (i) the 1:1 <u>mole</u> ratio from the equation and (ii) the relative <u>moles</u> of Cu^{2+} and Zn(s) used, as calculated in (e) <i>If candidate states that "more moles of zinc were present" and this fits the calculated values in (e) – accept as the relative statement.</i> | 1 | [1] |
| (g) | ACE Interpretation | Shows $(25 \times 4.3 \times \text{candidate mean } \Delta T)$ with appropriate unit, J or kJ, on final answer. (Allow use of 4.2 or 4.18 without penalty) <i>Award this mark for the correct expression and unit OR where the expression is not shown, a correct evaluation of that expression and unit</i> | 1 | [1] |
| Where candidate has given a maximum temperature in (g), allow use here (ecf). Also allow use of ΔT calculated in this section. | | | | |
| (h) | ACE Interpretation | No mark is awarded in this section if there is no division by (moles of zinc) or by (moles of Cu^{2+}). Calculates <u>answer to (g)</u> moles of reagent not stated as being in excess in (f) <i>If (moles of zinc) is used in this expression, candidate may use either value from (e) or the mean of the (moles of zinc).</i> Examiner evaluates the candidate expression which should be: (i) correctly rounded for sig fig displayed, (allow variation of ± 1 on 3 rd significant figure) (ii) have a -ve sign on the final answer; (iii) be correctly converted to kJ | 1 1 | [2] |
| (i) | ACE Interpretation | Candidate identifies one source of error in the experiment. This must be related to: Apparatus used or method described – no human error allowed. <i>Heat loss is most likely error to be seen Accept reference to the graduation (precision) of the thermometer.</i> | 1 | [1] |
| (j) | ACE Improvement | Answer must follow on from (i) Suggests a way in which method could be improved <i>e.g. Use of a lid or increased insulation to minimise heat loss.</i> | 1 | [1] |
| Qn 1 | Total | | | [26] |

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| Question | Sections | Indicative material | Mark | |
|--|-------------------|---|------|-----|
| FA 3 is $\text{MnSO}_4(\text{s})$; FA 4 is $\text{PbCO}_3(\text{s})$; FA 5 is $\text{CuCO}_3(\text{s})$ | | | | |
| 2 (a) | MMO Collection | As FA 5 is heated, observes: green or blue solid turning black, or green/blue (solid) turning to a black solid or residue | 1 | [2] |
| | MMO Decisions | Tests gas given off with: <i>Ignore results</i> limewater, <i>in any of</i> a glowing (not burning) splint, <i>these tests</i> red litmus paper | 1 | |
| (b) | MMO Collection | Observes each of the following: colourless solution with FA 3 or colourless solution with FA 4 , and blue or green solution with FA 5 and observation of a gas evolved with FA 4 or with FA 5 . <i>[Second mark from (a) may be awarded here if not already given in (a)]</i> | 1 | [1] |
| (c) | ACE Conclusion | Identifies carbonate in FA 4 or FA 5 and refers to carbon dioxide; <i>providing there has been evidence in the tests:</i> <i>a positive test with limewater, or</i> <i>effervescence with dilute acid</i> or Identifies carbonate in FA 4 or FA 5 and refers to specific test for carbon dioxide and its result in the conclusion. | 1 | [1] |

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| Question | Sections | Indicative material | Mark | |
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| (d) | PDO Recording | (i) All observations in a single table. Both reagents are required <i>There must be no repetition of "headings".</i> | 1 | |
| | MMO Collection | (ii) Reports addition of reagents to excess whenever a precipitate is formed on first addition of the reagent. (Minimum of 2 ppt) | 1 | |
| | | (iii) white / off-white / buff / (light or pale) brown precipitate with solution from FA 3 . Precipitate insoluble in excess <u>with both reagents</u> and turning brown (light or pale brown precipitate darkening) recorded for at least one of the reagents | 1 | |
| | ACE Conclusions | (iv) Give one mark for both observations. FA 4 – white precipitate – both reagents. soluble in excess NaOH; insoluble in excess NH ₃ (aq). and FA 5 – blue precipitate – both reagents. insoluble in excess NaOH; soluble in excess NH ₃ (aq) or colour goes to dark/deep blue. <i>Mark conclusions consequentially to observations.</i> | 1 | |
| | | (v) Expected cations: FA 3 (Mn ²⁺) and FA 5 (Cu ²⁺) <i>Minimum observations required:</i> <i>Mn²⁺ – off-white (buff, pale or light brown) ppt with each reagent but NOT from white ppt alone.</i> <i>Allow from white ppt turning brown.</i> <i>Cu²⁺ – blue ppt insoluble in excess NaOH</i> or <i>dark blue colour with aqueous NH₃</i> | 1 | |
| | | (vi) Identifies Pb ²⁺ and Al ³⁺ as possible cations. (a single consequential ion is acceptable) | 1 | |
| | | | | [6] |

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| Question | Sections | Indicative material | Mark | |
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| (e) | MMO Decisions | <p>If no pair of ions is given in (d), no mark can be awarded in this section</p> <p><i>Mark consequentially</i></p> <p>Selects appropriate reagent to distinguish between any pair of cations identified in (d). For Pb^{2+}/Al^{3+} accept HCl, H_2SO_4 KI or chromate/dichromate <i>The candidate should name a reagent, e.g. potassium dichromate.</i></p> <p><i>If $Cr_2O_7^{2-}$, or dichromate is given as the reagent the (aq) state symbol must also be given or reference made to an aqueous solution of the ions.</i></p> | 1 | |
| | MMO Collection | <p><i>If selected reagent is suitable; mark consequentially for chosen reagent and Pb^{2+}.</i></p> <p>For Pb^{2+}/Al^{3+} FA 4 gives white precipitate with HCl and with H_2SO_4 and yellow precipitate with chromate/dichromate or iodide. <i>Ignore any conclusion.</i></p> | 1 | [2] |
| (f) | MMO Collection | <p>Observes as only reaction: FA 3 gives white precipitate with $Ba(NO_3)_2$ which is insoluble in dilute nitric acid, but <i>Ignore any white ppt or cloudiness with FA 3 and silver nitrate, and</i> <i>ignore cation precipitates on adding $NH_3(aq)$</i></p> | 1 | |
| | ACE Conclusions | <p><i>Accept a dash in the boxes for reaction of FA 3, FA 4 and FA 5 with barium nitrate and with silver chloride as evidence of "no reaction" with that reagent</i></p> <p>A conclusion that fits observations for (i) barium chloride with all solutions or (ii) silver nitrate with all solutions</p> | 1 | [2] |
| Qn 2 | Total | | | [14] |