

MARK SCHEME for the May/June 2008 question paper

9701 CHEMISTRY

9701/31

Paper 31 (Advanced Practical Skills 1), maximum raw mark 40

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

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2008 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



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Generic Mark Scheme for Papers 31 and 32

| Skill | | Breakdown of marks | |
|---|----------|--|---------|
| Manipulation, measurement and observation | 16 marks | Successful <u>collection</u> of data and observations | 8 marks |
| | | <u>Quality</u> of measurements and observations | 4 marks |
| | | <u>Decisions</u> relating to measurements or observations | 4 marks |
| Presentation of data and observations | 12 marks | <u>Recording</u> data and observations | 5 marks |
| | | <u>Display</u> of calculation and reasoning | 3 marks |
| | | Data <u>layout</u> | 4 marks |
| Analysis, conclusions and evaluation | 12 marks | <u>Interpretation</u> of data or observations and identifying sources of error | 6 marks |
| | | Drawing <u>conclusions</u> | 5 marks |
| | | Suggesting <u>improvements</u> | 1 mark |

Statement Bank

MANIPULATION, MEASUREMENT AND OBSERVATION (MMO)

Successful collection of data and observations (Collection)

| | |
|-----------|---|
| C1 | Set up apparatus correctly |
| C2 | Follow instructions given in the form of written instructions or diagrams |
| C3 | Use apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour, solubility or quantity of materials |
| C4 | Make measurements using pipettes, burettes, measuring cylinders, thermometers, and other common laboratory apparatus |

Quality of measurements or observations (Quality)

| | |
|-----------|--|
| Q1 | Make accurate and consistent measurements and observations |
|-----------|--|

Decisions relating to measurements or observations (Decisions)

| | |
|------------|---|
| De1 | Decide how many tests or observations to perform |
| De2 | Make measurements that span a range and have a distribution appropriate to the experiment |
| De3 | Decide how long to leave experiments running before making readings |
| De4 | Identify where repeated readings or observations are appropriate |
| De5 | Replicate readings or observations as necessary |
| De6 | Identify where confirmatory tests are appropriate and the nature of such tests |

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PRESENTATION OF DATA AND OBSERVATIONS (PDO)

Recording of data and observations (Recording)

| | |
|-----------|--|
| R1 | Present numerical data, values or observations in a single table of results |
| R2 | Draw up the table in advance of taking readings/making observations so that they do not have to copy up their results |
| R3 | Include in the table of results, if necessary, columns for raw data, for calculated values and for analyses or conclusions |
| R4 | Use column headings that include both the quantity and the unit and that conform to accepted scientific conventions |
| R5 | Record raw readings of a quantity to the same degree of precision and observations to the same level of data |

Display of calculation and reasoning (Display)

| | |
|------------|--|
| Di1 | Show their working in calculations, and the key steps in their reasoning |
| Di2 | Use the correct number of significant figures for calculated quantities |

Data layout (Layout)

| | |
|-----------|--|
| L1 | Choose a suitable and clear method of presenting the data, e.g. tabulations, graph or mixture of methods of presentation |
| L2 | Use the appropriate presentation medium to produce a clear presentation of the data |
| L3 | Select which variables to plot against which and decide whether the graph should be drawn as a straight line or a curve |
| L4 | Plot appropriate variables on clearly labelled x- and y-axes |
| L5 | Choose suitable scales for graph axes |
| L6 | Plot all points or bars to an appropriate accuracy |
| L7 | Follow the ASE recommendations for putting lines on graphs |

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ANALYSIS, CONCLUSIONS AND EVALUATION (ACE)

Interpretation of data or observations and identify sources of error (Interpretation)

| | |
|------------|---|
| I1 | Describe the patterns and trends shown by tables and graphs |
| I2 | Describe and summarise the key points of a set of observations |
| I3 | Find an unknown value by using co-ordinates or intercepts on a graph |
| I4 | Calculate other quantities from data, or calculate the mean from replicate values, or make other appropriate calculations |
| I5 | Determine the gradient of a straight line |
| I6 | Evaluate the effectiveness of control variables |
| I7 | Identify the most significant sources of error in an experiment |
| I8 | Estimate, quantitatively, the uncertainty in quantitative measurements |
| I9 | Express such uncertainty in a measurement as an actual or percentage error |
| I10 | Show an understanding of the distinction between systematic errors and random errors |

Drawing conclusions (Conclusions)

| | |
|-------------|--|
| Con1 | Draw conclusions from an experiment, giving an outline description of the main features of the data, considering whether experimental data supports a given hypothesis, and making further predictions |
| Con2 | Draw conclusions from interpretations of observations, data and calculated values |
| Con3 | Make scientific explanations of the data, observations and conclusions that they have described |

Suggesting Improvements (Improvements)

| | |
|-------------|--|
| Imp1 | Suggest modifications to an experimental arrangement that will improve the accuracy of the experiment or the accuracy of the observations that can be made |
| Imp2 | Suggest ways in which to extend the investigation to answer a new question |
| Imp3 | Describe such modifications clearly in words or diagrams |

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| Skill | Total marks | Breakdown of marks | | | Question 1 | Question 2 |
|---|-------------|--|-------|---|------------|------------|
| | | Statement | Marks | | | |
| Manipulation, measurement and observation (MMO) | 16 marks | Successful <u>collection</u> of data and observations | C | 8 | 2 | 6 |
| | | <u>Quality</u> of measurements and observations | Q | 4 | 4 | 0 |
| | | <u>Decisions</u> relating to measurements of observations | De | 4 | 2 | 2 |
| Presentation of data and observations (PDO) | 12 marks | <u>Recording</u> data or observations | R | 5 | 3 | 2 |
| | | <u>Display</u> of calculation and reasoning | Di | 3 | 3 | 0 |
| | | Data <u>layout</u> | L | 4 | 4 | 0 |
| Analysis, conclusions and evaluation (ACE) | 12 marks | <u>Interpretation</u> of data or observations and identifying sources of error | I | 6 | 6 | 0 |
| | | <u>Drawing conclusions</u> | Con | 5 | 0 | 5 |
| | | <u>Suggesting improvements</u> | Imp | 1 | 0 | 1 |
| Total | | | | | 24 | 16 |

The Examiner is to check all subtractions on Supervisor and candidate scripts.

Record Supervisor values for titres in **(a)** and **(b)** on the front cover of the Supervisor's script.

Where a Supervisor has not provided titre information or where the Supervisor value is suspect (more than half the candidates in the Centre scoring zero marks in **(a)** or **(b)**) list the candidate values and attempt to obtain a suitable "average/mean" from these values.

Correct units

One of three forms acceptable.

Use of solidus, e.g. / cm³

Unit in brackets, e.g. (cm³)

In words, e.g. volume in cubic centimetres

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| Question | Sections | Statement | Indicative material | Mark | |
|----------|-----------------------|-----------|--|------|-----|
| 1 (a) | MMO Quality | Q | <p>Cross out any titration labelled as rough unless only titration recorded.</p> <p>Give two marks if the titre in (a) within 0.2 cm³ of the Supervisor.</p> <p>Give one of these marks for a titre of 0.20+ to 0.50 cm³.</p> <p><i>If titres are repeated – assess the value closer to that obtained by the Supervisor.</i></p> | 2 | [2] |
| (b) | MMO Quality | Q | <p>Titre in (b) within 0.2 cm³ of Supervisor.</p> <p><i>Treat repeated titres as in (a)</i></p> | 1 | [1] |
| (c) | ACE Interpretation | I4 | <p>Correctly calculates (to 3 or 4 significant figures) the predicted end-point from titres (a) and (b)</p> $\frac{\text{titre (a)}}{\text{titre (a) - titre (b)}} \times 12$ | 1 | [1] |
| (d) | PDO Recording | R1 | <p>Results incorporated into a single table (volume of FA 3, burette readings, and titre)</p> <p>(a) and (b) need not be included if titration data fully included in those sections.</p> | 1 | |
| | | R2 | <p>Table drawn up in advance of taking readings. Selected volumes of FA 3 must be sequential.</p> <p><i>Must include (a) and (b) which can be at beginning, at end or entered sequentially.</i></p> | 1 | |
| | MMO Collection | R4 | <p>Correct column or row headings <u>and units</u> (see page 1 for acceptable form of units).</p> <p><i>Minimum – volume of FA 3 and titre.</i></p> | 1 | |
| | | C2 | <p>Selects four additional volumes of FA 3 to add.</p> | 1 | |
| | MMO Decisions | C4 | <p>Makes all volume measurements of FA 2 and FA 3 with a burette.</p> <p><i>(all burette readings and/or volumes/titres recorded to 2 dp or to nearest 0.05 cm³).</i></p> | 1 | |
| | | De2 | <p>Candidate selects four points around the predicted “end-point” (or 20 cm³), either</p> <p>(i) one value to left and three to right, or</p> <p>(ii) two values to each side.</p> <p><i>If there are only three additional points give this mark if one value to left and two values to right.</i></p> <p><i>The C2 and De2 marks can be awarded if volumes of FA 3 have been selected but the titration not performed.</i></p> | 1 | [6] |

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|----------------|-----------------------|--|--|-----|-----|
| (e) | PDO Layout | L4 | Clearly and correctly labelled axes. <i>Accept volume of FA 2 or FA 2 / cm³ or FA 2 / ml, etc. as a label. Units not required.</i> | 1 | |
| | | L5 | Suitable scales selected. More than ½ of each axis used. <i>Allow “difficult” scale on x-axis but only if it easily fits the selected values of FA 3.</i> | 1 | |
| | | L6 | All points (including values from (a) and (b)) plotted to within ½ small square in either direction and in the correct square. | 1 | |
| | | L7 | 2 continuous straight lines drawn, each passing close to the majority of points. (Minimum of 2 points on either side of the end-point) – meeting on x-axis. | 1 | |
| | ACE Interpretation | I3 | Reads, to nearest small square, the x-axis value of the intersection of the two lines. <i>Intersection need not be on the x-axis.</i> <i>Where the left-hand line only has been drawn (or there is a right hand line with no plotted points) allow the intersection of the left-hand line with the x-axis providing there are at least 3 points close to the line drawn.</i> | 1 | |
| MMO Quality | Q | Not more than one anomalous point (off Examiner selected “best-fit” left-hand line) on plotted graph. <i>Minimum – three well-spaced points on or close to line.</i> <i>Do not award this mark if the points are “bunched” in a small area of the paper.</i> | 1 | [6] | |
| (f) | MMO | De5 | Identifies valid titre to be repeated or states correctly that no titre needs repeating. <i>Only award this mark if two lines (allow curves) have been drawn using plotted data for each line.</i> <i>If lenient in awarding L7 mark in (e) be tighter in this section.</i> | 1 | [1] |
| Calcs | PDO Display | Di1 | Shows working in all sections attempted. | 1 | |
| | | Di2 | 3 or 4 significant figures in final section answers to (g) / (h) – if attempted. | 1 | [2] |

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|-----|--------------------|-----|--|--------------------|-----|
| (g) | ACE Interpretation | I4 | Calculates $M_r = 392$ (stated or used). <i>Check any expression, adding A_r values to confirm that the values add up to 392 if no total given.</i> | 1 | [2] |
| | | I4 | Expression or calculated value: $\frac{15.68}{\text{cand } M_r} \times \frac{25.0}{1000} \quad \text{or}$ $0.04 \times \frac{25}{1000} \quad \text{or}$ $1(.00) \times 10^{-3}$ <i>Do not penalise incorrect evaluation of a correct expression.</i> | 1 | |
| (h) | ACE Interpretation | I4 | Calculates: $\frac{\text{intercept from graph}}{1000} \times 0.025$ | 1 | [1] |
| (i) | ACE Interpretation | I4 | Expression or calculation: $\frac{\text{ans(g)}}{\text{ans(h)}}$ | 1 | [2] |
| | PDO Display | Di2 | candidate values evaluated correctly to 3 significant figures. <i>Candidate must use an answer to (g) and (h) for the award of this mark (expression may be inverted).</i> | 1 | |
| | | | | [Total: 24] | |

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| FA 4 (0.1 mol dm ⁻³) NH ₄ I (actually NaI), FA 5 (0.1 mol dm ⁻³) Al ₂ (SO ₄) ₃ , FA 6 (0.1 mol dm ⁻³) Zn(NO ₃) ₂ | | | | | |
|--|--------------------|------|---|---|-----|
| 2 (a) | PDO Recording | R1 | Data in single table. <i>No repeat of reagents or reactants.</i> <i>Allow for single reagent and three solutions.</i> | 1 | |
| | MMO Decisions | De1 | Selects silver nitrate, Ag ⁺ (aq) or solution containing Ag ⁺ as one reagent. | 1 | |
| | | De1 | Select (aqueous) ammonia as 2 nd reagent to use with AgNO ₃ or selects soluble lead salt or Pb ²⁺ (aq) or solution containing Pb ²⁺ as separate reagent. <i>If ion is given with no state symbol or reference to the ion being in solution - penalise once only.</i> <i>Ignore incorrect formulae for reagents if intention is clear.</i> | 1 | |
| | MMO Collection | C3 | Records correct observations for both reagents selected (FA 4 contains the iodide). <i>Ignore observations for FA 5/FA 6 – unless observations for iodide in these solutions.</i> <i>Where all three reagents have been selected allow two out of three correct observations.</i> | 1 | |
| | ACE Conclusions | Con2 | Correct conclusion (from one piece of evidence) that FA 4 contains iodide ion. <i>Allow this conclusion if AgNO₃ or Pb(NO₃)₂ used as a single reagent.</i> | 1 | [5] |
| (b) | PDO Recording | R5 | Observations to show degree of precision – addition of NaOH to excess where a precipitate has been observed on addition of NaOH. | 1 | |
| | MMO Collection | C3 | <i>A precipitate must be recorded with FA 5 <u>and/or</u> FA 6.</i> Records white ppt soluble in excess with FA 5 white ppt soluble in excess with FA 6 <i>Ignore FA 4 column.</i> | | |
| (c) | MMO Collection | C3 | Records white ppt insoluble in excess with FA 5 white ppt soluble in excess with FA 6 <i>Ignore FA 4 column.</i> | 1 | [1] |

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|-----|-----------------|------|---|---|-----|
| (d) | MMO Collection | C3 | Records white ppt with FA 5 insoluble in acid no ppt with FA 6 | 1 | [2] |
| | MMO Collection | C3 | Records no ppt or no reaction for FA 4 with reagent in each of tests (b) , (c) and (d)(i) – addition of BaCl_2 . <i>Accept blank boxes as no reaction</i> | 1 | |
| (e) | MMO Collection | C3 | Records yellow ppt with FA 4 , soluble/partially soluble on heating or yellow ppt with FA 4 and forming crystals or (more) precipitate on cooling. <i>Accept precipitate forms as an acceptable observation when cooling the solution.</i> <i>Accept shiny precipitate/sparkly solid/spangles as equivalent to observing crystal formation.</i> and no ppt with FA 6 <i>Ignore FA 5, unless yellow ppt formed.</i> | 1 | [1] |
| (f) | ACE Conclusions | | Marks in this section must be based on evidence from the tests performed. All formulae used in this section must be correct (<i>identified ions or reagents</i>). <i>It is acceptable to refer back to (e.g. test (a)) providing the observation mark was awarded for that test.</i> <i>Allow named compounds or chemically correct formulae as well as ions .</i> | 1 | [4] |
| | | Con3 | Identifies I^- as the anion in FA 4 and explains two observations leading to that conclusion. <i>Minimum observation for I^- is yellow precipitate with silver ions, soluble in ammonia.</i> or <i>yellow precipitate with silver ions and with lead ions.</i> | 1 | |
| | | Con3 | Identifies Al^{3+} and SO_4^{2-} as the ions in FA 5 and explains the observations leading to that conclusion. <i>Minimum observation for Al^{3+} is white precipitate insoluble in excess ammonia.</i> <i>Minimum observation for SO_4^{2-} is white precipitate with barium chloride.</i> | 1 | |
| | | Con3 | Identifies Zn^{2+} as the cation in FA 6 and explains the observations leading to that conclusion. <i>Minimum observation for Zn^{2+} is white precipitate soluble in excess ammonia.</i> | 1 | |
| | | Con3 | States that NH_4^+ and NO_3^- have not been identified. <i>This may be recorded at any point in (f).</i> | | |

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|-----|----------------|------|---|---|-------------|
| (g) | ACE Improve | Imp2 | NaOH, Al and heat used to test for NO_3^- would also liberate ammonia from NH_4^+ so would not be specific to NO_3^- . <i>Candidates must show clear understanding of why the solution must be tested for ammonium ion before being tested for nitrate.</i> | 1 | [1] |
| | | | | | [Total: 16] |