

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

9701/31

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

| Question | Sections | Indicative material | Mark | |
|----------------|---|---|------|-----|
| 1 (a) | PDO Recording | (i) Presents data in single table of results – <i>to include volume of FA 2, initial and final temperatures and temperature change.</i> | 1 | |
| | | (ii) All columns correctly labelled with appropriate unit shown. <i>Must use solidus, brackets or describe unit fully in words. If units not included in column headings every entry must have the correct unit shown.</i> | 1 | |
| | MMO Collection | (iii) All thermometer readings recorded to 0.5°C | 1 | |
| | | (iv) Follows instructions – uses 10, 20, 30, 40, 50 cm ³ of FA 2 + two additional volumes | 1 | |
| | MMO Decisions | (v) One extra volume of FA 2 on either side of the maximum for the first five expts. or Two extra volumes between identical values for the first five expts. or Two extra volumes the same side as the next highest reading. | 1 | |
| | MMO Quality | (vi) and (vii) Check and correct ΔT where necessary. <i>(If multiple readings for max. T then apply hierarchy: take value of consistent readings; take average and correct to nearest 0.5°C)</i> Compare temp rise with that obtained by the Supervisor (<i>Expected value is 14.0°C</i>) For 30 cm ³ FA 2 : Award (vi) and (vii) for a temp rise of 0.0°, 0.5°, 1.0°C <i>Award (vi) only for a difference of 1.5°C</i> | 2 | |
| MMO Quality | (viii) and (ix) Check and correct ΔT where necessary. Compare temp rise with that obtained by the Supervisor (<i>Expected value is 13.5°C</i>) For 40 cm ³ FA 2 : Award (viii) and (ix) for a temp rise of 0.0°, 0.5°, 1.0°C <i>Award (viii) only for a difference of 1.5°C</i> | 2 | | |
| | | | | [9] |

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| Question | Sections | Indicative material | Mark | |
|----------|---|---|------------------------------|-----|
| (b) | PDO Layout | <p>(i) Temperature (rise) plotted on <i>y-axis</i> against volume (of FA 2) or FA 2 added /cm³ on <i>x-axis</i>. Clearly labelled axes (ignore units unless T, ΔT or V used as labels)</p> <p>(ii) Uniform and sensible scales that allow points to be plotted in at least half of the squares on each axis. (6 × 4 big squares). (0,0) may be considered – as an additional point or with a line going through it</p> <p>(iii) Visual check the “sweep” of all points, for all experiments recorded. Check the plotting of points for 10, 30 and 50 cm³ of FA 2 (and any other “suspect” point) If any point is missing and that experiment was not carried out, check adjacent point <i>Points should be within ½ of a small square, in the correct square</i> Do not award if T plotted instead of ΔT</p> <p>(iv) Appropriate lines drawn through the ascending and descending <u>points</u>. (<i>Ignore any deviation through rounding at the maximum temperature rise</i>) Do not award if both straight lines and curves drawn or there is any forced change in gradient.</p> | 1 1 1 1 | [4] |
| (c) | ACE Interpretation | <p>Reads from the graph (<i>to within ½ small square</i>) the volume of FA 2 at the intersection of two lines. Allow rounding to the closest cm³ Do not award this mark if the lines/curves have been rounded at the maximum ΔT.</p> | 1 | [1] |
| (d) | PDO Layout | <p>Explains that the temperature rise is the dependent variable or Volume of FA 2 is the independent variable/one that is controlled/one that you vary (<i>or words to that effect</i>)</p> | 1 | [1] |
| (e) | ACE Conclusion | <p>Gives correct equation for the reaction (<i>ignore state symbols</i>) 2NaOH + H₂SO₄ → Na₂SO₄ + 2H₂O or NaOH + H₂SO₄ → NaHSO₄ + H₂O</p> | 1 | [1] |
| (f) | PDO Display ACE Interpretation | <p>Working is shown in (f)(i) (involves volumes and concentration, 2.0 mol dm⁻³) and (f)(ii) (<i>any clear mole ratio</i>)</p> <p>Has correct expression for $\frac{10.00}{1000} \times 2.0$ or an answer of 0.02(00) in (f)(i) and 0.04(00) in (f)(ii) <i>There is no ecf within (f)</i></p> | 1 1 | [2] |
| (g) | PDO Display | <p>Expression given in the question paper is correctly evaluated to 2 or 3 significant figures. <i>Allow a volume, read from rounded curves to be used in this expression. Normal rounding rules apply to the sig fig.</i></p> | 1 | [1] |

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| Question | Sections | Indicative material | Mark | |
|--------------|--------------------|--|-------------|-----|
| (h) | ACE Interpretation | Uses the expression: (answer from (c) + 10) × 4.3 × ΔT read from graph | 1 | [2] |
| | | Divides the answer above by answer to (f)(i) and gives answer in kJ mol ⁻¹ with –ve sign <i>Do not award this second mark unless candidate has calculated (a volume of soln × 4.3 × ΔT)</i> | 1 | |
| (i) | ACE Improvements | <u>Advantage</u> of burette: Lower % error or more accurately calibrated (<i>must refer to or infer scale/graduations/markings/divisions</i>) | 1 | [2] |
| | | <u>Disadvantage</u> of burette: Takes longer to add the FA 2 | 1 | |
| (j) | ACE Interpretation | Candidate gives two of the following as significant sources of error. Heat loss (to the surroundings) Thermometer graduated at 1°C intervals Drying of cup/thermometer Initial temps of both solutions should be taken <i>Other acceptable sources of error may be seen.</i> | 1 | [1] |
| (k) | ACE Interpretation | (i) Maximum error in reading a 1°C graduated thermometer is given as 0.5°C | 1 | [2] |
| | | (iii) Calculates answer in $\frac{\text{answer in (k)(i)} \times 2}{\text{answer in (k)(ii)}} \times 100\%$ | 1 | |
| Total | | | [26] | |

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Question 2

| Question | Sections | Indicative material | Mark | |
|--|-------------------|---|-------------|-----|
| FA 3 is BaCl ₂ (aq); FA 4 is MgBr ₂ (aq) [MgCl ₂ + NaBr]; FA 5 is CaI ₂ (aq) [CaCl ₂ + NaI]; FA 6 is K ₂ CrO ₄ (aq) | | | | |
| 2 (a) | MMO Decisions | Chooses silver nitrate/Ag ⁺ (aq)/solution containing Ag ⁺ ions followed by (aqueous) ammonia. | 1 | [1] |
| (b) | PDO Recording | Results for three solutions and the two reagents from (a) (or three reagents if (a) : 'Ag ⁺ + NH ₃ ', Pb ²⁺) if recorded in a single table (<i>no repetition of solutions or reagents</i>) | 1 | [2] |
| | MMO Collection | Give one mark for correct observations with FA 3 , FA 4 and FA 5 . FA 3 – white ppt with Ag ⁺ , soluble in NH ₃ (aq) FA 4 – cream ppt with Ag ⁺ , partially soluble or insoluble in NH ₃ (aq) (allow “creamy” not “creamy white”) FA 5 – yellow ppt with Ag ⁺ , insoluble in NH ₃ (aq) If Ag ⁺ and Pb ²⁺ in (a) , all observations must be correct (ignore any ‘extra’ NH ₃ if not in (a)) (Pb ²⁺ : white, white, yellow ppts respectively) | 1 | |
| (c) | ACE Conclusion | Mark consequentially on observations in (b) Expected conclusion Identifies FA 3 as solution containing Cl ⁻ from “white ppt with Ag ⁺ (soluble in NH ₃ (aq)) given as evidence. <i>Mark consequentially – ecf allowed here.</i> <i>(No retrospective to observations)</i> | 1 | [1] |
| (d) | MMO Collection | Mark each of the boxes and see whether correct columns or rows give the better mark. Award the better mark. See table below for the expected observations | 1 1 1 | [3] |

| | FA 3 | FA 4 | FA 5 |
|------------------------|---|--|--|
| + NaOH(aq) | ignore | white ppt | white ppt or “cloudiness” |
| + NH ₃ (aq) | no ppt (allow reference to “cloudiness”/“slight white ppt”) | white ppt | no ppt/no change/ no reaction |
| + FA 6 | yellow ppt | no ppt/no change/ no reaction/yellow soln | no ppt/no change/ no reaction/yellow soln |

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|---|-----------------|---|---|-----|
| (e) | MMO Collection | Records (yellow) <u>solution turning orange</u> (or <i>wtte</i> , e.g. orange solution forms) | 1 | [1] |
| (f) | ACE Conclusions | Mark consequentially on observations in (d) and (e) Expected conclusions: Anion in FA 6 is chromate, CrO_4^{2-} , from yellow soln turning orange in (e) or yellow ppt with FA 3 in (d) <i>provided FA 3 not also identified from (d) and FA 3 contains Ba^{2+} from observations with NaOH and NH_3 (or just NaOH if obs with FA 4 and FA 5 are correct with it) or FA 6 in (d)</i> | 1 | [1] |
| FA 7 is a tertiary alcohol; FA 8 is an aldehyde; FA 9 is a ketone; FA 10 is a primary alcohol | | | | |
| (g) | MMO Collection | One mark for two correct observations with FA 7 | 1 | [3] |
| | | One mark for correct observations with FA 8 and FA 9 | 1 | |
| | | One mark for two correct observations with FA 10 See table below for expected observations | 1 | |

| reagent | observations | | | |
|----------------------|--------------|--|-------------|---|
| | FA 7 | FA 8 | FA 9 | FA 10 |
| acidified dichromate | no reaction | | no reaction | (colour change to green/blue-green/cyan/turquoise (solution not ppt) |
| 2,4-DNPH | no reaction | yellow ppt | yellow ppt | |
| Tollens' reagent | no reaction | silver mirror or black/grey solution or ppt | | no reaction |

| | | | | |
|-----|-----------------|--|---|-------------|
| (h) | ACE Conclusions | No ecf from (g) FA 7 contains the tertiary alcohol from <u>no reaction with all three reagents</u> or <u>no reaction</u> with dichromate and 2,4-DNPH provided there is no CON in the observation with Tollens' FA 8 contains the aldehyde from the silver (mirror), black or grey precipitate or solution with ammoniacal silver nitrate Allow from brown ppt if it is the only positive result with Tollens'. | 1 | [2] |
| | | | 1 | |
| | Total | | | [14] |