**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

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

# MARK SCHEME for the May/June 2012 question paper

# for the guidance of teachers

## 9701 CHEMISTRY

**9701/51** Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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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| Question | Sections | Indicative material | Mark |
|---|---|---|---|
| 1 (a) (i) | PLAN Problem | States that the moles of copper(II) hydroxide increase as the molar concentration of copper(II) sulfate increases and sketches a line from the origin with an initial positive gradient. Ignore any subsequent plateau or maximum on this line. | [1] |
| (ii) | | A straight line terminating at the point of saturation with marked co-ordinates: award 2 marks. | [1] |
| | | A straight line clearly terminating within the grid but without marked co-ordinates: award 1 mark. | [1] |
| | | A line (not necessarily straight) which does not terminate at the saturation point but with the co-ordinates marked: award 1 mark. This line can plateau after the saturation point. | |
| (b) | PLAN Problem | **(i)** concentration of copper(II) sulfate. | [1] |
| | | **(ii)** moles of copper(II) hydroxide | [1] |
| (c) | PLAN Method | Indicates at least five experiments. These may be shown in the table in **1(e).** Five blank rows in the table are acceptable. | [1] |
| | | A range of concentrations over at least 0.8 mol $dm^{-3}$, which must cover 1.0 mol $dm^{-3}$, up to a maximum of 1.39. Accept a range of mass of copper(II) sulfate (with solution volume) that has been calculated satisfying the same concentration criteria. | [1] |
| | | Filtering/centrifuging | [1] |
| | | Method of drying and weighing the precipitate. Include washing with water (and propanone), (air) drying and weighing (to constant mass). Do not accept direct heating, blotting or a statement that the precipitate is simply left to dry. | [1] |
| | | A suitable calculation of a molarity, even if greater than 1.39 ($M_r$ of the copper(II) sulfate must be used). Check that the solution is made up to the appropriate volume and not that a mass is added to a fixed volume of water. | [1] |
| (d) | PLAN Method | Identifies that copper(II) sulfate is harmful/a danger to the environment. | [1] |
| | | Identifies that sodium hydroxide is corrosive (from the hazcard information). | [1] |
| | | Give one mark for a precaution for either hazard of (chemical) resistant gloves or large dilution when disposing of chemicals. | [1] |

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| **(e)** | PLAN<br>Method | This table must match the plan in **1(c).** Five or four columns are required depending on whether serial dilution is used to prepare the solutions:<br>Either **(i)** mass of copper(II) sulfate/g or **(ii)** volume of copper sulfate solution/$cm^3$ and volume of water/$cm^3$ for serial dilutions;<br>mass/weight of copper(II) hydroxide/g;<br>concentration of copper(II) sulfate/$mol.dm^{-3}$;<br>number of moles of copper(II) hydroxide (no unit).<br>The full word for the unit can be used with or without / or ().<br>Ignore other column headings and units.<br>If Five or Four are fully correct, two marks; four or three correct, one mark; otherwise zero. | [2] |
| | | | **[Total: 15]** |

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|---|---|---|---|
| **2 (a)** | ACE Data | The required two column headings temperature, (A + 273), /K and volume, (B + 26), /$cm^3$ are fully correct. The full word for the unit can be used with or without / or ().<br><br>Both columns are fully completed to the correct number of significant figures. Allow 2 errors. | [1]<br><br>[1] |
| **(b)** | ACE Data | Label the *x*-axis temperature and the *y*-axis volume. Any correct unambiguous label is acceptable e.g. column label (A). Units must be present in the accepted forms. The plotted points must cover at least half the grid in both directions and all points must be on the given grid. If a true origin has been scaled in and the candidate's line is extrapolated back to there then the origin is to be included as a "plotted point" in the assessment of covering half the grid in both directions. This mark not available for other plots.<br><br>Check the plotting of points 1, 3, 8, 10 and any obvious error.<br><br>Give one mark for drawing a 'straight-line of best fit' (allow 'ecf' here from incorrectly plotted points). | [1]<br><br>[1]*<br><br>[1]* |
| **(c)** | ACE Evaluation | Incorrect plots of **(i)** volume/temp °C and **(ii)** volume change/temp will still allow these marks to be accessed. Any other wrong plots will not.<br>Allow the candidate to select up to five anomalies which must include that furthest from the line.<br><br>All the anomalous points are circled on the grid or unambiguously stated in the text.<br><br>For each of the two different anomalies an appropriate explanation gains one mark.<br><br>Point 3 (V low). Gas not equilibrated with the <u>increased</u> temperature, OR volume read before all the gas attained the <u>increased</u> temperature. OR volume read before 5 minutes at the <u>increased</u> temperature.<br><br>Point 8 (V high). Gas not equilibrated with the <u>decreased</u> temperature, OR volume read before all the gas attained the <u>decreased</u> temperature. OR volume read before 5 minutes at the <u>decreased</u> temperature.<br><br>If the candidate suggests that the gas is not equilibriated for both anomalous points but does not specify the direction of temperature change to that point, award 1 mark. | <br><br>[1]<br><br>[2] |

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|---|---|---|---|
| **(d)** | ACE data | (i) For, two pairs of construction lines on the graph drawn from the line to the axes and for correctly deducing the graph values of these two intercepts, give one mark. There has to be some indication on the graph of the intercepts used to calculate the gradient. These could be table points, provided they are indicated on the graph. If the true origin has been used in calculating the slope then only one pair of lines and one intercept is necessary.<br><br>A correctly calculated value of the slope using the candidate's figures. The mark is for the magnitude (ignore units). If the candidate used the true origin in the slope calculation then two zeros are not needed in the calculation.<br><br>If the slope expression is inverted, then the calculation mark is lost but the intercept value mark can be gained.<br><br>(ii) For a correctly read intercept at 273K give one mark. This mark is available for other permitted wrong plots as in 2(c), but for a volume change/temp plot 26 $cm^3$ has to be added to the read intercept. Allow a calculated volume only if the candidates line on the graph was extrapolated to the true origin. Units must be included. | [1]*<br><br>[1]*<br><br>[1] |
| **(e)** | ACE Evaluation | The data is reliable as most (6 or more) of the points/results/data lie on the line of best fit. Accept few anomalous points.<br><br>If there are 6 or more points not on the line then accept that the results are not reliable. | [1] |
| **(f)** | ACE Conclusion | These marks not available for other plots.<br><br>For a statement that the 'law' is justified because a straight line (direct proportionality) is obtained give one mark.<br><br>The data confirms the relationship V = kT or that volume is directly proportional to absolute temperature. Calculations showing that V/T is the same for more than 1 point on the graph are worth 1 mark. | [1]<br><br>[1] |
| **(g)** | ACE Conclusion | A second line on the grid above the original line. This second line to have a greater slope (not parallel) and not touching the original line unless at the true origin (if used). Again, this mark is available for the other permitted plots as in **2(c)**. | [1] |
| | | (* is mark available for other plots) | |
| | | | **[Total: 15]** |

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