**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

**9701/53** 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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UNIVERSITY of CAMBRIDGE
International Examinations

| Question | Sections | Indicative material | Mark |
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| 1 (a) | PLAN Problem | **(i)** & **(ii)** States the moles of product increase (as the moles on ammonium nitrate (V)/reactant increases) and the x-axis is labelled moles ammonium nitrate (V)/reactant.<br><br>Accept proportional or directly proportional for increase. In **(ii)** it has to be clearly stated that both products are increasing with the increase in ammonium nitrate moles.<br><br>There are a 1:1 & 1:3 ratios correctly given either in text or in the graph. No curves or plateaus<br><br>Two lines starting at the origin with moles on the *y*-axis are correctly labelled with temperature or gas identity and the higher temperature line has a slope greater than that of the other line. No curves or plateaus. | [1]<br><br>[1]<br><br>[1] |
| (b) | PLAN Problem | (i) moles of ammonium nitrate.<br><br>(ii) moles of nitrogen(I) oxide.<br><br>Accept mass/weight of ammonium nitrate and volume of nitrogen(I) oxide together for one mark. | [2] |
| (c) | PLAN Method | A diagram which shows a heated (closed but with an output tube) piece of apparatus. No water baths or hot plates<br><br>Showing a condenser and collector for water (e.g. cooled (ice) U-tube) connected to the ammonium nitrate apparatus. If a gas collector is after this piece then the water collector must be gas tight. If no gas collection is attempted after the water condenser then it must be open to air. Allow a Liebig condenser provided it fulfils the same conditions as stated above.<br><br>Showing a calibrated collecting device accept label syringe/ burette/measuring cylinder as equal to calibrated. To be labelled with size (minimum 10 $cm^3$). To be in train after the water condenser – if a condenser not present – then connected to the heating apparatus. | [1]<br><br>[1]<br><br>[1] |

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| **(d)** | PLAN<br>Method | At least five experiments. May be in table (Five+ rows in the table counts as 5 experiments).<br><br>States intended gas volumes. The range to run as a minimum from x $cm^3$ to 3 times x $cm^3$ where x > = 10 $cm^3$ and maximum volume does not exceed collector capacity.<br><br>A correct calculation for a mass of ammonium nitrate that will produce one of the gas volumes above. Or a volume from a stated mass. This calculation is not restricted to the capacity of the gas collector.<br><br>Stopping at a constant volume of gas (not constant mass)/ all solid disappeared/syringe plunger stops moving. Must be an <u>observation</u> not a deduction as – all decomposed or no more gas. | [1]<br><br>[1]<br><br>[1]<br><br>[1] |
| **(e)** | PLAN<br>Method | Identification of ammonium nitrate as oxidising or explosive (Not $NH_4NO_3$ combustible) from the hazcard information and giving a suitable precaution – keeping away from combustible material / wear (chemical) resistant gloves. Accept hot apparatus with heat resistant gloves/tongs. | [1] |
| **(f)** | PLAN<br>Method | Four columns are required.<br><br>mass/weight (not amount) of ammonium nitrate (/g); volume of nitrogen(I) oxide (/$cm^3$) (/$dm^3$); number of moles of ammonium nitrate (no unit); number of moles of nitrogen(I) oxide (no unit).<br><br>The full word for the unit can be used with or without / or ().<br><br>Four fully correct, two marks; three correct, one mark; otherwise zero. | [2] |
| | | | **[Total: 15]** |

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| **2 (a)** | ACE Data | The required two column headings PV and (A × B) and /kPacm$^3$ then 1/V and (1/B) and /cm$^{-3}$ are fully correct. The full word for the unit can be used with or without / or (). All 3 features of the column headings are required. Can accept standard form in the unit only e.g. 3.05 data as /10$^3$ kPacm$^3$ or (10$^3$ kPacm$^3$). Allow data in standard form.<br><br>Both columns are fully completed to the correct number of significant figures and all the calculations in each column are correct, (allow two errors). | [1]<br><br>[1] |
| **(b)** | ACE Data | Check for a slightly downward sloping continuous curve. No straight/horizontal lines. Ignore the line before the first point and after the last point. | [1] |
| **(c)** | ACE Data | Label the *x*-axis pressure and the *y*-axis 1/volume. Labels can be column headings or unambiguous descriptions with the correct unit in the correct form (/ or ()). The axes must be scaled so that the plotted points must cover at least half the grid in both directions and all points must be on the given grid. A true origin is required on both scales.<br><br>**This mark not available for other plots.** Allow subsequent marks for inverted plots.<br><br>First check any outlying points then check the plotting of points 1, 5, 7, 9 & 10. All 10 points present.<br><br>Line/curve starting at the origin, accept being straight up from the origin to point 5 (170 kPa) then curving to include the remaining 4 points. Due to differences in plotting, the straight line may extend further and remain correct provided it terminates in a curve and provided it is the line of best fit. | [1]<br><br>[1]*<br><br>[1]* |
| **(d)** | ACE Evaluation | **These marks not available for other plots.**<br><br>All the anomalous points are circled on the grid or unambiguously stated in the text. (Selections on the line negate this mark.) (max 5 anomolies)<br><br>An appropriate explanation gains one mark. Point 7 (1/V high, V low). Volume measured at a lower temperature. For a misplot of low 1/V, accept higher temperature. | <br><br>[1]<br><br>[1] |

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| **2 (e)** | ACE<br>Data | Two pairs of construction lines on the graph drawn from the line in the initial straight section to the axes and correctly deduces the values of these two intercepts. If the true origin has been used in calculating the slope then only one pair of lines and one intercept is necessary.<br><br>These construction lines must be in the initial straight section of the plot into the origin and would normally not exceed 170 kPa on x. If the actual plotting and straight line of the candidate exceeds this point a construction that is in the straight line section is correct. No construction lines into curved sections can be used. If the initial straight line is produced onwards then any intercept more than 170 kPa is correct.<br><br>Allow data from points on the plotted line to be used provided there is some indication on the plot that the point has been used in slope calculation. If the candidate has drawn a straight line rather than a curve then the construction may be anywhere along the line provided the line is drawn into the origin. Do not allow gradients on tangents to a curve unless the curve is at the origin or at $x = 0$ or $y = 0$.<br><br>A correctly calculated value of the slope using the candidate's figures. Check the candidate's calculation and correct rounding. 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. Value of slope is around 2.8–2.9 × $10^{-4}$.<br><br>If the slope expression is inverted, then the calculation mark is lost but the intercept value mark can be gained. | [1]*<br><br>[1]* |
| **(f)** | ACE<br>Conclusion | **These marks not available for other plots.** This must relate to the initial shape of their plot.<br><br>(i) The 'law' is justified.<br><br>**AND**<br><br>(ii) In the (initial section of the plot/at lower pressure) the data produce a straight line from the origin.<br><br>(iii) The graph is a curve or not a straight line. Or the graph has a variable gradient.<br><br>The best way to verify a relationship is by way of a straight line plot (not a curve). | <br><br><br><br>[1]<br><br>[1]<br><br>[1] |

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| **(g)** | ACE Evaluation | **These marks not available for other plots. Treat these points as the same question**<br><br>(i) This is the area of linearity/straight line/constant gradient. Accept (at low pressures) the gas behaves ideally or (an area) where Boyle's law is obeyed.<br><br>(ii) It is the 1/proportionality constant. It's the value of 1/k. | [1]<br><br>[1] |
| | | (* is mark available for other plots) | |
| | | | **[Total: 15]** |