

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Level**

## **MARK SCHEME for the October/November 2013 series**

### **9701 CHEMISTRY**

**9701/51**

Paper 5 (Planning, Analysis, Evaluation),  
maximum raw mark 30

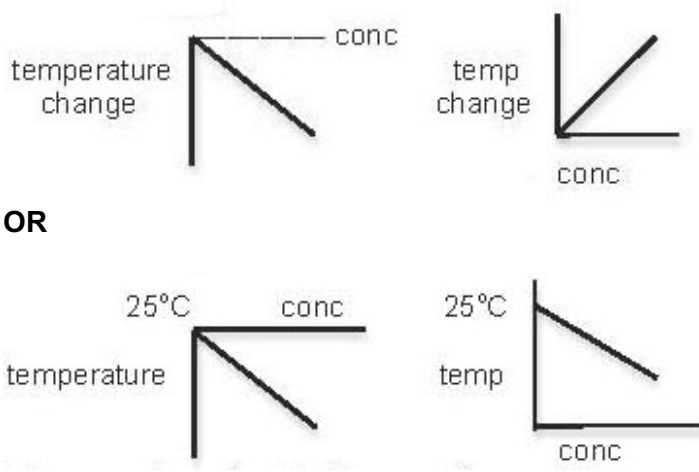
This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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| Question  | Expected Answer                                                                                                                                                                                             | Mark       |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1 (a) (i) | (The temperature would) decrease<br><br>The lattice enthalpy is more negative/exothermic than the (sum of the) enthalpies/energies of hydration.                                                            | 1<br><br>1 |
| (ii)      |  <p>OR</p> <p>OR ecf from 1(a)(i)</p>  | 2          |

|               |                                            |                 |              |
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|                |                                                                                                                                                                                                                                                                                                              |                    |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| <b>(b) (i)</b> | concentration/concentration change                                                                                                                                                                                                                                                                           |                    |
| <b>(ii)</b>    | temperature change/decrease in temperature (allow ecf on <b>(a)(i)</b> )                                                                                                                                                                                                                                     | <b>1</b>           |
| <b>(c)</b>     | Diagram shows a container labelled with its capacity (between 25 cm <sup>3</sup> and 250 cm <sup>3</sup> ) and with the thermometer in a solution.                                                                                                                                                           | <b>1</b>           |
|                | The apparatus is insulated and has a lid.                                                                                                                                                                                                                                                                    | <b>1</b>           |
|                | Thermometer range must include 25 °C and with a precision of between 0.1 °C and 0.5 °C.                                                                                                                                                                                                                      | <b>1</b>           |
| <b>(d)</b>     | A minimum of 5 workable experiments using masses or concentrations.                                                                                                                                                                                                                                          | <b>1</b>           |
|                | Measures initial and final temperatures.                                                                                                                                                                                                                                                                     | <b>1</b>           |
|                | Measures a volume of water <b>AND</b> the volume of water will fit into container labelled in <b>(c)</b> .                                                                                                                                                                                                   | <b>1</b>           |
|                | States a mass which is the maximum for a volume of water stated.                                                                                                                                                                                                                                             | <b>1</b>           |
| <b>(e)</b>     | Ammonium nitrate may cause a fire/explosion so must not be ground up <b>OR</b> dilute to less than 0.5 mol dm <sup>-3</sup> before disposal.                                                                                                                                                                 | <b>1</b>           |
| <b>(f)</b>     | Columns must include units:<br>Mass of ammonium nitrate used / any mass unit<br>Volume / mass of water used / any volume or mass units<br>Initial temperature / °C<br>Final temperature / °C<br>Temperature fall / change in temperature / °C<br>Concentration of ammonium nitrate / any concentration units |                    |
|                | Four columns correct                                                                                                                                                                                                                                                                                         | <b>1</b>           |
|                | Five or six columns correct                                                                                                                                                                                                                                                                                  | <b>1</b>           |
|                |                                                                                                                                                                                                                                                                                                              | <b>[Total: 15]</b> |

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| 2                                                                                  | (a)                                                                                                                                                                                                                                                       | <table><tr><th>F</th><th>G</th><th>H solubility</th></tr><tr><th>D–C / g</th><th>C–B / g</th><th>[(F × 100)] / G / g/<br/>100 g</th></tr><tr><td>1.25</td><td>25.00</td><td>5.00</td></tr><tr><td>1.25</td><td>20.00</td><td>6.25</td></tr><tr><td>5.00</td><td>25.00</td><td>20.00</td></tr><tr><td>7.76</td><td>19.40</td><td>40.00</td></tr><tr><td>11.11</td><td>23.00</td><td>48.30</td></tr><tr><td>11.75</td><td>25.00</td><td>47.00</td></tr><tr><td>9.62</td><td>21.00</td><td>45.81</td></tr><tr><td>9.10</td><td>20.00</td><td>45.50</td></tr><tr><td>11.25</td><td>25.00</td><td>45.00</td></tr><tr><td>13.35</td><td>30.00</td><td>44.50</td></tr></table> | F       | G                             | H solubility | D–C / g | C–B / g | [(F × 100)] / G / g/<br>100 g | 1.25 | 25.00 | 5.00 | 1.25 | 20.00 | 6.25 | 5.00 | 25.00 | 20.00 | 7.76 | 19.40 | 40.00 | 11.11 | 23.00 | 48.30 | 11.75 | 25.00 | 47.00 | 9.62 | 21.00 | 45.81 | 9.10 | 20.00 | 45.50 | 11.25 | 25.00 | 45.00 | 13.35 | 30.00 | 44.50 |  |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------------------------|--------------|---------|---------|-------------------------------|------|-------|------|------|-------|------|------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|--|
|                                                                                    |                                                                                                                                                                                                                                                           | F                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | G       | H solubility                  |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | D–C / g                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | C–B / g | [(F × 100)] / G / g/<br>100 g |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | 1.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 25.00   | 5.00                          |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | 1.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 20.00   | 6.25                          |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | 5.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 25.00   | 20.00                         |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | 7.76                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 19.40   | 40.00                         |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | 11.11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 23.00   | 48.30                         |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | 11.75                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 25.00   | 47.00                         |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | 9.62                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 21.00   | 45.81                         |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | 9.10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 20.00   | 45.50                         |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | 11.25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 25.00   | 45.00                         |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    |                                                                                                                                                                                                                                                           | 13.35                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 30.00   | 44.50                         |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
| Heading for final column calculating the solubility is given correctly with units. | 1                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    | 1                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
| All data is to 2 decimal places. Allow 1 error.                                    |                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    | 1                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
| Data in final column is correct. Allow 1 error in computation.                     |                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
| (b)                                                                                | The x-axis must start at zero and be labelled 'temperature / °C' <b>OR</b> T / °C and y-axis as 'solubility (of sodium sulfate) g/100g'.<br>Plotted points must cover at least half the grid in both directions.                                          | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    | All 10 points plotted correctly.                                                                                                                                                                                                                          | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    | First (left-hand) curve is smooth passing through (or extremely close to) all the points and does not deviate to accommodate a mis-plot or incorrect point. Curve intersects with a second curve at or above the candidate's solubility for experiment 5. | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
|                                                                                    | Second curve (right hand) is smooth passing through (or extremely close to) all the points and does not deviate to accommodate a mis-plot or incorrect point.                                                                                             | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
| (c)                                                                                | the temperature is read correctly<br>the solubility is read correctly                                                                                                                                                                                     | 1<br>1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
| (d) (i)                                                                            | Cross is on the 40 g / 100 g line and to the right of the point plotted at 30 °C.                                                                                                                                                                         | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
| (ii)                                                                               | Transition temperature would be higher as intersection of curves would be at a higher temperature.                                                                                                                                                        | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |
| (e)                                                                                | Solubility is 47.6 (g / 100g)<br><br>1.2% <b>OR</b> 1.21% <b>OR</b> 1.28% <b>OR</b> 1.3%                                                                                                                                                                  | 1<br><br>1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |                               |              |         |         |                               |      |       |      |      |       |      |      |       |       |      |       |       |       |       |       |       |       |       |      |       |       |      |       |       |       |       |       |       |       |       |  |

|               |                                            |                 |              |
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|            |                                                                                                                                                                                                                                                                                  |                      |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>(f)</b> | $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$<br>endothermic because solubility increases with increasing temperature<br>(or reverse argument)<br>$\text{Na}_2\text{SO}_4$<br>exothermic because solubility decreases with increasing temperature<br>(or reverse argument) |                      |
|            | For endothermic and exothermic correctly assigned<br>For providing the correct reasons                                                                                                                                                                                           | <b>1</b><br><b>1</b> |
|            |                                                                                                                                                                                                                                                                                  | <b>[Total: 15]</b>   |