NOVEMBER 2002

GCE Advanced Level

<table>
<thead>
<tr>
<th>MARK SCHEME</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM MARK : 30</td>
</tr>
<tr>
<td>SYLLABUS/COMPONENT : 9701 /5</td>
</tr>
<tr>
<td>CHEMISTRY (PRACTICAL)</td>
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</tbody>
</table>
Question 1

(a) Accuracy

Comparing experiments 2 and 3.

The Examiner calculates for each experiment the value of (Volume of FA 1 x time in seconds). Record the values above the respective columns. Subtract the smaller from the larger and then calculate:

\[ \% \text{ Difference} = \frac{\text{Larger (Vxt)} - \text{Smaller (Vxt)}}{\text{Larger (Vxt)}} \times 100 \]

(Record this % on the script)

Award accuracy marks as follows

(If the times for experiment 1 and experiment 2 differ by more than 10% of larger, work with the value that will give the better accuracy mark)

<table>
<thead>
<tr>
<th>% Difference</th>
<th>Mark</th>
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<tbody>
<tr>
<td>Up to 5%</td>
<td>5</td>
</tr>
<tr>
<td>5+% to 10%</td>
<td>4</td>
</tr>
<tr>
<td>10+% to 15%</td>
<td>3</td>
</tr>
<tr>
<td>15+% to 20%</td>
<td>2</td>
</tr>
<tr>
<td>20+% to 30%</td>
<td>1</td>
</tr>
</tbody>
</table>

Comparing experiments 2 and 4.

(If the times for experiment 1 and experiment 2 differ by more than 10% of larger, work with the value that will give the better accuracy mark)

The Examiner calculates for each experiment the value of (Volume of FA 2 x time in seconds). Record the values below the respective columns. Subtract the smaller from the larger and then calculate:

\[ \% \text{ Difference} = \frac{\text{Larger (Vxt)} - \text{Smaller (Vxt)}}{\text{Larger (Vxt)}} \times 100 \]

(Record this % on the script)

Award accuracy marks as follows

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<td>20+% to 30%</td>
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</tbody>
</table>
Compare experiments 2 and 3

(b) (i)  **Give one mark for** FA 2 (X) and FA 3 (Iodine), ignore water.

(ii) **Give one mark for** FA 1 (Sulphuric acid), not water.

(iii) **Give one mark for** a qualitative statement linking change in rate to changed volume/concentration of acid.

Give one mark for a semi-quantitative statement relating rate (not time) and volume/concentration that is **supported by the practical results**. To accept a statement that doubling the volume/concentration doubles the rate, a minimum of three marks must have been awarded for accuracy.

Give one mark for a quantitative statement in mathematical form or a statement as to Order of Reaction that is **supported by the practical results**. To accept a statement of Rate ∝ [Acid] or First Order (with respect to acid), a minimum of 3 marks must have been awarded for accuracy.

If FA 2 is given as the variable in b(ii) and FA 1 in c(ii); marks may still be awarded for b(iii) and c(iii) as the reaction is first order for each reagent.

Compare experiments 2 and 4

(c) (i) **Give one mark for** FA 1 (Sulphuric acid) and FA 3 (Iodine), ignore water

(ii) **Give one mark for** FA 2 (X), not water.

(iii) **Give one mark for** a qualitative statement linking change in rate to changed volume/concentration of X.

Give one mark for a semi-quantitative statement relating rate (not time) and volume/concentration that is **supported by the practical results**. To accept a statement that doubling the volume/concentration doubles the rate, a minimum of three marks must have been awarded for accuracy.

Give one mark for a quantitative statement in mathematical form or a statement as to Order of Reaction that is **supported by the practical results**. To accept a statement of Rate ∝ [X] or First Order (with respect to X), a minimum of 3 marks must have been awarded for accuracy.

(d) **Give one mark if**

- Volume of FA 1 = 20 cm³
- Volume of FA 2 = 20 cm³ (Allow multiples of these volumes)
- Volume of FA 3 < 4 cm³
- Volume of water = (4.0 − Volume of FA 3) cm³

**Total for Question 1**
2 Assessment of Planning Skills

Numbered sequence and Table of Results

Give one mark for each of the following points.
They may be found in the text on page 4 or in the table of results on page 5.

Record the letter of the point being awarded close to the scoring point in the script and tick, ✓, the box in the margin to show the particular point has been considered.

a weighing a suitable container – only one of the following
test-tube, boiling-tube, crucible, evaporating dish/basin

b weighing container + sample - Not weighing solid alone or into the container

c heating and re-weighing after heating

d any evidence of re-heating and weighing again

e (heating) to constant mass (stated or described)

Give one mark for each of the following points.
They may be found in the text on page 4 or in the table of results on page 5.

f calculating the mass of water lost in the experiment

g calculating moles of water/anhydrous sodium carbonate using 18/106 correctly

h calculating moles of water per mole of anhydrous sodium carbonate

i \[
\% \text{ water lost on standing} = \left(\frac{10 - \text{moles of water in (h)}}{10}\right) \times 100
\]

or \[
= 100 - \left(\frac{\text{moles of water in (h)}}{10}\right) \times 100
\]

OR

f calculating the mass of water lost in the experiment

g calculating the mass of \( \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} \) that would give the mass of anhydrous solid left at the end of the experiment.

\[
\text{mass of } \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} = \text{mass of anhydrous } \text{Na}_2\text{CO}_3 \times \frac{286}{106}
\]

h Calculating the mass of water in the mass of \( \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} \) calculated in (g).

\[
\text{mass in (g)} - \text{mass of anhydrous sodium carbonate}
\]

i \[
\% \text{ water lost on standing} = \frac{\text{mass of water in (h)} - \text{mass of water lost in (f)}}{\text{mass of water calculated in (h)}} \times 100
\]

OR
f calculating the mass of water lost in the experiment

g Calculating, from practical results, the % of water in Na₂CO₃ₓH₂O and calculating, from formula, the % of water in Na₂CO₃₁₀H₂O.

h Calculating moles of water per mole of anhydrous sodium carbonate

\[ \frac{\text{% water}}{\frac{18}{\frac{\text{% anhydrous sodium carbonate}}{106}}} \]  for Na₂CO₃ₓH₂O.

i \[ \text{% water lost on standing} = \frac{(10 \text{ - moles in (h))}}{10} \times 100 \]

OR

f calculating the mass of water lost in the experiment

g Calculating the moles of anhydrous Na₂CO₃ remaining. \( \frac{\text{mass of Na}_2\text{CO}_3}{106} \) and

\[ M_r \text{ for Na}_2\text{CO}_3\times\text{H}_2\text{O} \left( \frac{\text{mass of Na}_2\text{CO}_3\times\text{H}_2\text{O}}{\text{moles of anhydrous Na}_2\text{CO}_3} \right) \]

h Moles of water lost = \( \frac{286 - M_r \text{ calculated in (g)}}{18} \)

i \[ \text{% water lost on standing} = \frac{\text{(moles of water in (h))}}{10} \times 100 \]

Other variations of the calculation may be encountered – try to fit the method to the steps in (g), (h), (i) above.

Total for Question 2 is 9
Total for Paper 30.

Turn over for Examples
In all these calculations assume that 10.0g or Na\textsubscript{2}CO\textsubscript{3}.xH\textsubscript{2}O is heated and produces 5.0g of anhydrous Na\textsubscript{2}CO\textsubscript{3}.

**Method 1**

\[
\frac{5.0}{106.0} = 0.0472 \text{ moles of anhydrous sodium carbonate.} \quad \frac{5.00}{18.0} = 0.2778 \text{ moles of water}
\]

\[
\begin{align*}
0.2778 &= 5.89 \text{ moles of water / mole of sodium carbonate} \\
0.0472 &= 5.89 \text{ moles of water / mole of sodium carbonate}
\end{align*}
\]

\[
\% \text{ water lost on standing} = \frac{10 - 5.89}{10} \times 100 = 41.1\%
\]

**Method 2**

5.0 g of Na\textsubscript{2}CO\textsubscript{3} left after heating

This came from \[
\frac{286}{106} \times 5.0 = 13.49 \text{ g of Na}_2\text{CO}_3.10\text{H}_2\text{O}
\]

Mass of water = (13.49 - 5.0) = 8.49 g

\[
\% \text{ water lost on standing} = \frac{(8.49 - 5.00)}{8.49} \times 100 = 41.11\%
\]

**Method 3**

\[
\% \text{ water in Na}_2\text{CO}_3.x\text{H}_2\text{O} = \frac{5.0}{10.0} = 50\%
\]

\[
\% \text{ water in Na}_2\text{CO}_3.10\text{H}_2\text{O} = \frac{180.0}{286.0} = 62.9\%
\]

Moles of water/mole of sodium carbonate

In Na\textsubscript{2}CO\textsubscript{3}.xH\textsubscript{2}O = \[
\frac{50}{18} = 5.89
\]

\[
\% \text{ Water lost on standing} = \frac{(10 - 5.89)}{10} \times 100 = 41.1\%
\]

**Method 4**

Moles of Na\textsubscript{2}CO\textsubscript{3} and hence Na\textsubscript{2}CO\textsubscript{3}.xH\textsubscript{2}O = \[
\frac{5.0}{106} = 0.0472 \text{ moles}
\]

\[
M_i \text{ of Na}_2\text{CO}_3.\text{xH}_2\text{O} = \frac{10.0}{0.0472} = 212
\]

Moles of water lost on standing = \[
\frac{286 - 212}{18} = 4.11 \text{ moles}
\]

\[
\% \text{ of water lost on standing} = \frac{4.11}{10} \times 100 = 41.1\%
\]