

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

NOVEMBER 2002

GCE Advanced Level

MARK SCHEME

MAXIMUM MARK : 30

SYLLABUS/COMPONENT :9701 /5

**CHEMISTRY
(PRACTICAL)**



UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

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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:

$$\% \text{ Difference} = \frac{\text{Larger (Vxt)} - \text{Smaller (Vxt)}}{\text{Larger (Vxt)}} \times 100 \quad (\text{Record this \% on the script})$$

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)

% Difference	Mark
Up to 5%	5
5+% to 10%	4
10+% to 15%	3
15+% to 20%	2
20+% to 30%	1

5

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:

$$\% \text{ Difference} = \frac{\text{Larger (Vxt)} - \text{Smaller (Vxt)}}{\text{Larger (Vxt)}} \times 100 \quad (\text{Record this \% on the script})$$

Award accuracy marks as follows

% Difference	Mark
Up to 5%	5
5+% to 10%	4
10+% to 15%	3
15+% to 20%	2
20+% to 30%	1

5

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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 \propto [Acid] or First Order (with respect to acid), a minimum of 3 marks must have been awarded for accuracy.

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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 \propto [**X**] or First Order (with respect to **X**), a minimum of 3 marks must have been awarded for accuracy.

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- (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

1

Total for Question 1

21

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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)

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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

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

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

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).
(mass in (g) - mass of anhydrous sodium carbonate)

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

OR

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- f calculating the mass of water lost in the experiment
- g Calculating, from practical results, the % of water in $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ and calculating, from formula, the % of water in $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$.
- h Calculating moles of water per mole of anhydrous sodium carbonate
- $$\left(\frac{\% \text{ water}}{18} \div \frac{\% \text{ anhydrous sodium carbonate}}{106} \right) \text{ for } \text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}.$$
- 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 Na_2CO_3 remaining. $\left(\frac{\text{mass of } \text{Na}_2\text{CO}_3}{106} \right)$ and
- $$M_r \text{ for } \text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}. \left(\frac{\text{mass of } \text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}}{\text{moles of anhydrous } \text{Na}_2\text{CO}_3} \right)$$
- h Moles of water lost = $\left(\frac{286 - M_r \text{ calculated in (g)}}{18} \right)$
- 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.

4

Total for Question 2 is 9

Total for Paper 30.

Turn over for Examples

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In all these calculations assume that 10.0g of $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ is heated and produces 5.0g of anhydrous Na_2CO_3 .

Method 1

$$\frac{5.0}{106.0} = 0.0472 \text{ moles of anhydrous sodium carbonate, } \frac{5.00}{18.0} = 0.2778 \text{ moles of water}$$

$$\frac{0.2778}{0.0472} = 5.89 \text{ moles of water / mole of sodium carbonate}$$

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

Method 2

5.0 g of Na_2CO_3 left after heating

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

$$\text{Mass of water} = (13.49 - 5.0) = 8.49 \text{ g}$$

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

Method 3

$$\% \text{ water in } \text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O} = \frac{5.0}{10.0} = 50\%$$

$$\% \text{ water in } \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} = \frac{180.0}{286.0} = 62.9\%$$

Moles of water/mole of sodium carbonate

$$\text{In } \text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O} = \frac{\frac{50}{18}}{\frac{50}{106}} = 5.89$$

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

Method 4

$$\text{Moles of } \text{Na}_2\text{CO}_3 \text{ and hence } \text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O} = \frac{5.0}{106} = 0.0472 \text{ moles}$$

$$M_r \text{ of } \text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O} = \frac{10.0}{0.0472} = 212$$

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

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