General Certificate of Education
Advanced Subsidiary Examination
June 2013

Chemistry CHM3X/TN

Unit 3X AS Externally Marked Practical Assignment

Teachers' Notes Confidential

A copy should be given immediately to the teacher responsible for GCE Chemistry

Estimated entries must be submitted to AQA in order for centres to receive hard copies of the materials to be used by candidates

Teachers' Notes

Confidential

These notes must be read in conjunction with the *Instructions for the Administration of the Externally Marked Practical Assignment: GCE Chemistry* published on the AQA Website.

An investigation of baking powder

Task 1 Thermal decomposition of sodium hydrogencarbonate

This involves measuring the mass of a sample of sodium hydrogencarbonate before and after heating. Direct heating with a Bunsen burner is used.

Task 1 Materials

Each candidate should be given the following reagent in a suitable closed container.

Reagent	State	Mass	Note
Sodium hydrogencarbonate	Solid	1.9 – 2.1 g	Labelled **'Sodium hydrogencarbonate for Task 1'** It is strongly recommended that centres purchase a fresh sample of sodium hydrogencarbonate and that it is not opened until shortly before the EMPA

General

It is the responsibility of the centre to ensure that the investigation works with the materials provided to the candidates **before** candidates carry out the task.

Spare supplies of all substances specified in these notes must be available.

Task 1 Apparatus

Each candidate will require the following:

Number	Apparatus
	access to a balance reading to at least two decimal places
1	small ceramic or nickel crucible
1	spatula
1	tripod
1	heat-proof mat
1	Bunsen burner
1	pipe-clay triangle
1	set of metal tongs suitable for picking up the crucible
	eye protection

In this task, each candidate is required to do 5 weighings. It is recommended that centres provide more than one balance per group.

Task 2 Determination of the enthalpy of neutralisation of sodium hydrogencarbonate

When sodium hydrogencarbonate is used in baking powder it reacts with the acids also present to release carbon dioxide. In this task, hydrochloric acid is used to neutralise a sample of solid sodium hydrogencarbonate. Candidates will measure the temperature at intervals over a short time period and record their results.

Task 2 Materials

Each candidate should be given the following reagents in suitable closed containers.

Reagents	Concentration / mol dm^{-3}	Quantity	Note
Hydrochloric acid	2.0	50 cm^3	Labelled **'Hydrochloric acid'**
Sodium hydrogencarbonate	Solid	3.5 – 4.0 g	Labelled **'Sodium hydrogencarbonate for Task 2'** It is strongly recommended that centres purchase a fresh sample of sodium hydrogencarbonate and that it is not opened until shortly before the EMPA

General

It is the responsibility of the centre to ensure that the investigation works with the materials provided to the candidates **before** candidates carry out the task.

Spare supplies of all substances specified in these notes must be available.

Turn over ▶

Task 2 Apparatus

Each candidate will require the following:

Number	Apparatus
1	50 cm^3 burette and stand
1	funnel suitable for filling a burette
1	analogue thermometer, measuring to 0.2 ºC or better, covering at least the range of 0–50 ºC
1	clamp and stand for the thermometer
1	stirrer
1	plastic cup (of a size suitable to fit into a 250 cm^3 beaker)
1	timer
1	250 cm^3 beaker
	a plentiful supply of distilled or deionised water
	eye protection
	access to a balance reading to at least two decimal places

Checking the thermometer reading

In step 5 of Task 2, candidates are instructed to ask their teacher to check their temperature reading. If a candidate does not read the thermometer correctly, the teacher must tell the candidate the correct reading. There is no penalty for an incorrect reading. The centre is not required to inform AQA of an incorrect reading.

Risk assessment and risk management

Risk assessment and risk management are the responsibility of the centre.

Notes from CLEAPSS

Technicians/teachers should follow safety data sheets provided by the supplier for handling reagents. The worldwide regulations covering the labelling of reagents by suppliers are currently being changed. Details about these changes can be found in leaflet GL101, which is available on the CLEAPSS Website. You will need to have a CLEAPSS login.

Teacher Results

A teacher must carry out both tasks, using similar apparatus and samples of the same stock solutions/chemicals as the candidates, in order to obtain teacher results. This must **not** be done in the presence of candidates.

Teacher Results
- are required for both tasks
- are required for each group of candidates
- must be recorded on the Teacher Results Sheets
- are used to assess the accuracy of candidates' results
- must be included with the scripts sent to the examiner.

In order to ensure that each candidate can be matched to the appropriate Teacher Results, teachers must
- complete all details on each Teacher Results Sheet
- ensure that all candidates complete all details on the Candidate Results Sheets, clearly identifying their teaching group and/or teacher.

Centres with more than one teaching set

Centres may wish to divide their candidates into manageable groups and to conduct the tasks at different times.

Assessment Advisers

If you have any queries about the practical work for the EMPA, please contact your Assessment Adviser. Contact details for your Assessment Adviser can be obtained by e-mailing your centre name and number to chemistry-gce@aqa.org.uk

Information to be given to candidates

Candidates **must not** be given information about an EMPA assessment until one week before Task 1. One week before Task 1, candidates should be given the following information.

The aims of these tasks are
- to find the change in mass of a sample of sodium hydrogencarbonate on heating
- to find the temperature change on neutralisation of a sample of sodium hydrogencarbonate and hydrochloric acid.

The main areas of the specification in the Written Test include Section 3.1.2 (Amount of Substance), Section 3.1.5 (Introduction to Organic Chemistry), Section 3.2.1 (Energetics) and Section 3.2.10 (Alcohols).

There **must** be no further discussion and candidates **must not** be given any further resources to prepare for the assessment.

Turn over ▶

Teacher Results Sheet for Task 1

A completed copy of this sheet must be included with the scripts sent to the examiner.

Centre Number | | | | | |

Teacher Name ..... Teacher Group .....

Results

Record your weighings in the table below. (All masses measured in grams to 2 decimal places.)

A	Mass of crucible	
B	Mass of crucible and sample	
C	Mass of crucible and sample after step 5	
D	Mass of crucible and sample after step 6	
E	Mass of crucible and sample after step 7	
F	Mass of sample before heating (Mass **B** – Mass **A**)	
G	Mass of sample after heating (Mass **E** – Mass **A**)	
	Percentage by mass of solid remaining (Mass **G** / Mass **F**) $\times$ 100	

This sheet may be photocopied

Teacher Results Sheet for Task 2

A completed copy of this sheet must be included with the scripts sent to the examiner.

Centre Number | | | | | |

Teacher Name ..... Teacher Group .....

Results

Record your results in the tables below.

Mass of $NaHCO_3$ and container / g	
Mass of empty container / g	
Mass of $NaHCO_3$ used in experiment / g	

Time / min	0	1	2	3	4	5	6	7	8	9	10
Temperature / °C					X						

An investigation of baking powder

Task 1 Thermal decomposition of sodium hydrogencarbonate

Baking powder contains sodium hydrogencarbonate. It is added to cake and bread mixtures so that they rise when cooked. During cooking, sodium hydrogencarbonate decomposes and releases carbon dioxide. This causes the mixture to rise.

In this Task, you will investigate the thermal decomposition of sodium hydrogencarbonate by measuring the mass of a sample before and after heating. The decomposition occurs readily above 80 ºC and carbon dioxide is evolved. The solid remaining is sodium carbonate which is stable at temperatures below 1000 ºC.

The equation for the decomposition is

$$2NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O$$

Procedure

- **Wear eye protection at all times.**
- **Assume that all solids are toxic.**
- **Read all of the following instructions and then design a table, on the Candidate Results Sheet for Task 1, to record your results.**
- **Record all masses to two decimal places.**

1 Weigh a clean, dry crucible. Record this mass.

2 Tip the sodium hydrogencarbonate provided into the clean, dry crucible. Record the total mass of the crucible and contents.

3 Set up a tripod and Bunsen burner on a heat-proof mat. Place a pipe-clay triangle on the tripod to support the crucible during heating.

4 Use the Bunsen burner, with the air hole half open, to heat the crucible and contents for about 10 minutes. After heating, leave the crucible to cool for about 5 minutes.

5 Carefully use the tongs to transfer the cooled crucible and contents to the balance. Record this total mass.

6 Return the crucible to the tripod and heat for a further 5 minutes. After heating, leave to cool for about 5 minutes. Again, carefully use the tongs to transfer the cooled crucible and contents to the balance. Record this total mass.

7 Repeat step 6. Record the final mass of the crucible and contents.

You are **not** required to do any further work in Task 1.
You will use your results in Section A of the Written Test.

An investigation of baking powder

Task 2 Determination of the enthalpy of neutralisation of sodium hydrogencarbonate

Baking powder contains sodium hydrogencarbonate. In this task, you will use hydrochloric acid to neutralise a sample of solid sodium hydrogencarbonate. You will measure the temperatures during this endothermic reaction and record your results.

Procedure

- **Wear eye protection at all times.**
- **Assume that all substances used are toxic and corrosive.**
- **Read all of the following instructions and then design two tables, on the Candidate Results Sheet for Task 2, to record your results.**

1 Rinse a burette with the 2.00 mol dm^{-3} hydrochloric acid provided. Set up the burette and use a funnel to fill it with this hydrochloric acid.

2 Use this burette to transfer precisely 30.0 cm^3 of the hydrochloric acid into a clean, dry plastic cup. Place this cup into a beaker to provide support and additional insulation.

3 Mount the thermometer in the cup using a clamp and stand. The bulb of the thermometer must be fully immersed in the solution. Place a stirrer in the cup.

4 Use a balance to weigh the total mass of the sodium hydrogencarbonate and the container provided. Record this mass to two decimal places.

5 Measure the temperature of the hydrochloric acid in the cup to one decimal place.

Have this temperature reading checked by your teacher.

6 When you are ready to start the experiment, stir the hydrochloric acid, measure the temperature and start the timer. Record this temperature in your table.

7 Continue to stir, measure and record the temperature at the first, second and third minutes.

8 At the fourth minute, add your weighed sample of sodium hydrogencarbonate.
Stir the mixture gently to minimise any spray from the vigorous reaction but do **not** measure the temperature at the fourth minute.
Keep your empty container.

9 Stir the mixture **gently** and **continuously** during the remainder of the experiment. Measure the temperature at the fifth minute. Then measure the temperature at each minute up to and including the tenth minute. Record each result in your table.

10 Weigh your empty container. Record this mass in your table.

You are **not** expected to do any further work in Task 2.
You will use your results in Section A of the Written Test.

Section A

These questions are about the tasks, an investigation of baking powder.

You should use Task Sheets 1 and 2, including your own Candidate Results Sheets, to answer these questions.

Answer **all** questions in the spaces provided.

1 (a) Use your results from **Task 1** to calculate the following masses:

the mass of sodium hydrogencarbonate in the crucible before heating

the mass of solid remaining in the crucible after the final heating.

1 (b) Use your answers to Question **1 (a)** to calculate the percentage, by mass, of solid remaining after heating.
Give your answer to one decimal place.

2 The equation for the thermal decomposition of sodium hydrogencarbonate is shown below.

$$2NaHCO_3(s) \longrightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

Use this equation to calculate the percentage atom economy for the formation of sodium carbonate from sodium hydrogencarbonate.
Show your working.

3 Calculate the difference between your answers to Questions **1 (b)** and **2**.
Express this difference as a percentage of your answer to Question **2**.

4 Assume that the maximum total error in using the balance to determine the mass of sodium hydrogencarbonate is ±0.01 g. This takes into account multiple measurements of mass.

Use your answer for the mass of sodium hydrogencarbonate before heating from Question **1 (a)** to calculate the percentage error in using the balance.

5 A student carried out **Task 1** on a different pure sample of sodium hydrogencarbonate. In this case, the mass of solid in the crucible at the end of the experiment was 87.3% of the original mass.

Compare this percentage with your answer to Question **2** and suggest an experimental reason for this student's result.

6 Use your results for **Task 2** to plot a graph of temperature (*y*-axis) against time on the grid on page 11.

Draw lines of best-fit for the points between 0 and 3 minutes and between 5 and 10 minutes.

Extrapolate both best-fit lines to the fourth minute.

7 Use your graph to determine the temperature change at the fourth minute.
Give your answer to the appropriate precision.

8 Use your answer to Question **7** to determine the heat energy change in **Task 2**.
Assume that the reaction mixture has a density of $1.00\,g\,cm^{-3}$, a volume of $30\,cm^3$ and a specific heat capacity of $4.18\,J\,K^{-1}\,g^{-1}$.
Show your working.

9 The hydrochloric acid used in **Task 2** was in excess.

Calculate the amount, in moles, of sodium hydrogencarbonate used in **Task 2**.
Hence, determine the enthalpy of neutralisation per mole of sodium hydrogencarbonate.
(If you were unable to complete Question **8** you may assume that the heat energy change in **Task 2** is 1250 J. This is **not** the correct value.)
Show your working.

Section B

Answer **all** questions in the spaces provided.

Baking powder

Baking powder contains sodium hydrogencarbonate and an acid or a mixture of acids. One acid that may be in baking powder is 2,3-dihydroxybutanedioic acid. This has the molecular formula $C_4H_6O_6$ and it is often referred to as tartaric acid.

10 Draw the structural formula of tartaric acid.

11 Write an equation for the reaction of tartaric acid ($C_4H_6O_6$) with sodium hydrogencarbonate to form a salt, carbon dioxide and water.

12 Substances that contain carbonate or hydrogencarbonate ions can be used to confirm the presence of an acid.

Identify **one** other substance that could be used to confirm the presence of acid groups in tartaric acid.
State the observation you would make when this other substance is added to an aqueous solution of tartaric acid.

13 It is known that tartaric acid contains alcohol and carboxylic acid functional groups only. A test can be used to show that tartaric acid contains secondary alcohol groups, **not** tertiary alcohol groups.

13 (a) Identify a reagent for this test and state the observation you would make for each type of alcohol.

13 (b) Suggest why this test **cannot** be used to distinguish between a primary alcohol and a secondary alcohol.

14 Baking powder usually contains starch. Starch is added to absorb any water vapour that may come into contact with the baking powder when the container is opened.

Deduce a reason why this water vapour needs to be absorbed.

15 Sodium hydrogencarbonate in baking powder forms carbon dioxide during the production of bread and cakes.

Suggest **one** advantage of having an acid in baking powder.

16 Safety information indicates that tartaric acid and its salts can act as muscle toxins. These can cause paralysis and possible death.

Suggest **one** reason why the use of tartaric acid in baking powder is **not** a hazard to health.

Section C

These questions test your understanding of the skills and techniques you have acquired during your AS course.

Answer **all** questions in the spaces provided.

17 Read the following instructions that describe how to make up a standard solution of a solid in a volumetric flask.
Answer the questions which follow.

'Take a clean 250 cm^3 volumetric flask. Use the balance provided and a clean, dry container, to weigh out the amount of solid required. Tip the solid into a clean, dry 250 cm^3 beaker and add about 100 cm^3 of distilled water. Use a stirring rod to help the solid dissolve, carefully breaking up any lumps of solid with the rod. When the solid has dissolved, pour the solution into the flask using a filter funnel. Add water to the flask until the level rises to the graduation mark.'

17 (a) Suggest **three** further instructions that would improve the overall technique in this account.

17 (b) In a series of titrations using the solution made up in Question **17 (a)**, a student obtained the following titres (all in cm^3).

Rough	1	2
25.7	25.20	25.35

State what this student must do in order to obtain an accurate average titre in this experiment.

18 Barium chloride solution was added, dropwise, to magnesium sulfate solution until no more white precipitate was formed. The mixture was filtered.

Give the formulae of the **two** main ions in the filtrate.

END OF QUESTIONS