OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY 2813/03/TEST

Practical Examination 1 (Part B – Practical Test)

Thursday **18 MAY 2006** Morning 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials:
Data Sheet for Chemistry
Candidate's Plan (Part A of the Practical Examination)
Scientific calculator

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read instructions and questions carefully.

INFORMATION FOR CANDIDATES

- In this part of the Practical Test, you will be assessed on the Experimental and Investigative Skills:
  Skill I Implementing
  Skill A Analysing evidence and drawing conclusions
  Skill E Evaluating evidence and procedures
- You may use a scientific calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
Planning	**16**	
Implementing & Analysing	**30**	
Evaluating	**14**	
TOTAL	**60**	

This question paper consists of 12 printed pages.

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Answer **all** the parts.

Introduction

In this examination, you will determine the enthalpy change for the reaction of anhydrous sodium carbonate with water to form hydrated sodium carbonate.

$$\underset{\text{anhydrous}}{Na_2CO_3(s)} + 10H_2O(l) \longrightarrow \underset{\text{hydrated}}{Na_2CO_3.10H_2O(s)}$$

In **Part 1**, you will determine the enthalpy change for the reaction of **anhydrous** sodium carbonate with sulphuric acid.

In **Part 2**, you will determine the enthalpy change for the reaction of **hydrated** sodium carbonate with sulphuric acid.

In **Part 3**, you will use Hess' Law to calculate the enthalpy change for the reaction of anhydrous sodium carbonate with water to form hydrated sodium carbonate.

Three chemicals are provided.

- Solid **A** is anhydrous sodium carbonate, about 4 g (two portions). **Irritant** 
- Solid **B** is hydrated sodium carbonate, about 10 g (two portions). **Irritant** 
- Solution **C** is aqueous sulphuric acid, of approximate concentration 2 mol dm^{-3}. **Corrosive** 

Part 1 Reaction of anhydrous sodium carbonate with sulphuric acid
Skills I + A (Implementing and Analysis) **[15 marks]**

Record all your readings in a table in the space on page 3.
You will carry out the experiment twice.

Using a pipette and filler, transfer 25.0 cm^3 of aqueous sulphuric acid, **C**, into the plastic cup in the beaker.
Measure the temperature of the acid and record it on page 3.
You may need to tilt the cup so that the thermometer bulb is completely immersed.

Weigh one of the containers with anhydrous sodium carbonate, **A**.
Record the mass on page 3.

The reaction that follows is vigorous.
Avoid inhaling any acid spray that may be produced.

Place the plastic cup and the beaker on the heat-proof mat provided.
Empty all of **A** from the container into the plastic cup.

Stir the mixture with the thermometer until the maximum temperature is reached.
Record the **maximum** temperature.
Calculate the temperature rise on page 3.

Weigh the empty container (that had contained **A**) and record the mass below.
Calculate the mass of anhydrous sodium carbonate you used.

Rinse out the plastic cup thoroughly.

Repeat the experiment, again using 25.0 cm^3 of aqueous sulphuric acid, **C**.
This time use the other container of anhydrous sodium carbonate, **A**.
Record the masses and temperatures in your table below.

Readings and calculations

Calculate the mean temperature rise obtained and the mean mass of **A** used.

mean temperature rise = ...°C

mean mass of **A** used = ...g

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Calculation

(a) (i) Complete the following formula

heat produced in Joules, J = mass of water × specific heat capacity × .....

(ii) Calculate the heat produced in the reaction, given:

- mass of water present in aqueous sulphuric acid = 25.0 g
- specific heat capacity of an aqueous solution = 4.2 J g^{-1} K^{-1}.

heat produced = ... J

(b) Calculate the mean number of moles of anhydrous sodium carbonate, Na_2CO_3, **A**, used in your experiments.

mean number of moles of Na_2CO_3 = ... mol

(c) **(i)** Complete the equation, including state symbols, for the reaction of sodium carbonate with sulphuric acid.

$Na_2CO_3(s) + H_2SO_4(aq) \longrightarrow$

(ii) Calculate the enthalpy change for the reaction of 1 mole of Na_2CO_3, in $kJ\,mol^{-1}$.

enthalpy change of reaction = ... $kJ\,mol^{-1}$

Part 2 Reaction of hydrated sodium carbonate with sulphuric acid
Skills I + A (Implementing and Analysis) [10 marks]

Rinse out your plastic cup from Part 1.

Record all your readings in a table in the space at the bottom of this page.

Using a pipette and filler, transfer 25.0 cm^3 of aqueous sulphuric acid, **C**, into the plastic cup in the beaker.
Measure the temperature of the acid and record it below.
You may need to tilt the cup so that the thermometer bulb is completely immersed.

Weigh one of the containers with hydrated sodium carbonate, **B**.
Record the mass below.

The reaction that follows is vigorous.
Avoid inhaling any acid spray that may be produced.

Place the plastic cup and the beaker on the heat-proof mat provided.
Empty all of **B** from the container into the plastic cup.

Stir the mixture with the thermometer until the minimum temperature is reached.
Record the **minimum** temperature.
Calculate the temperature drop below.

Weigh the empty container (that had contained **B**) and record the mass below.
Calculate the mass of hydrated sodium carbonate you used.

Rinse out the plastic cup thoroughly.

Repeat the experiment, again using 25.0 cm^3 of aqueous sulphuric acid, **C**.
This time use the other container of hydrated sodium carbonate, **B**.
Record the masses and temperatures in your table below.

Readings and calculations

mean temperature drop = ...°C

mean mass of **B** used = ...g

Calculation

(a) Calculate the heat absorbed in the reaction of hydrated sodium carbonate, **B**, with sulphuric acid.

Note – Assume that there is 6.3 g of water from the hydrated sodium carbonate, in addition to 25.0 g of water from the aqueous sulphuric acid.

heat absorbed = ... J

(b) Calculate the enthalpy change for the reaction of 1 mole of hydrated sodium carbonate with sulphuric acid, in kJ mol^{-1}.

The relative formula mass of hydrated sodium carbonate = 286.

enthalpy change of reaction = ... kJ mol^{-1}

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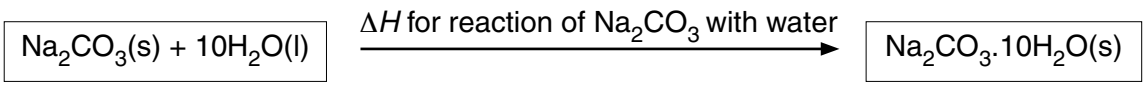
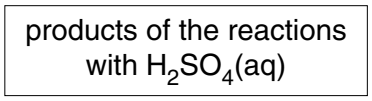
Part 3 Using Hess' Law **[5 marks]**

(a) Complete the Hess' Law enthalpy cycle below by drawing two arrows to represent the enthalpy changes you calculated in **Part 1** and **Part 2**.
Label the arrows with the calculated values of the enthalpy changes of reaction.

If you were unable to calculate the results in either Part 1 or 2, use the enthalpy changes below for your calculation.

- *for anhydrous sodium carbonate reacting with sulphuric acid,* $\Delta H = -20.6$ kJ mol^{-1}
- *for hydrated sodium carbonate reacting with sulphuric acid,* $\Delta H = +27.5$ kJ mol^{-1}





(b) Calculate the enthalpy change for the reaction of anhydrous sodium carbonate with water.

$$Na_2CO_3(s) + 10H_2O(l) \longrightarrow Na_2CO_3.10H_2O(s)$$

Show your working clearly.

enthalpy change of reaction = ... kJ mol^{-1}

(c) Safety

State and explain what you would do if you splashed some of the aqueous sulphuric acid on your hands.

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Part 4 Skill E (Evaluating evidence and procedures) [14 marks]

*Section **(b)** carries about half of the marks in Part 4.*

(a) A student suggested that the experiment in **Part 2** would be more accurate if the hydrated sodium carbonate crystals had been ground down until they were much finer.
State and explain whether or not you agree with this suggestion.

(b) Identify **three** sources of inaccuracy/unreliability in the experimental procedure. Suggest and explain ways that they could be reduced.

Note: do **not** include any ideas related to grinding down the crystals that you have written about in section **(a)**.

(c) State which source of error identified in section **(b)** would be the most significant and justify your answer.

(d) Suggest **two** reasons why it is **not** possible to determine the enthalpy change of hydration of anhydrous sodium carbonate accurately by adding water directly to anhydrous sodium carbonate and measuring the temperature rise.

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For Examiner's Use

END OF QUESTION PAPER