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OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

CHEMISTRY

2816/03/TEST

Practical Examination 2 (Part B – Practical Test)

CUP/T68097

Candidates answer on the question paper

OCR Supplied Materials:
- *Data Sheet for Chemistry* (inserted)

Other Materials Required:
- Candidate's Plan (Part A of the Practical Examination)
- Scientific Calculator

Tuesday 20 January 2009
Morning

Duration: 1 hour 30 minutes

2816032

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- 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.
- You may refer to your Plan produced for Part A.
- You will be awarded marks for the quality of written communication where this is indicated.
- A copy of the *Data Sheet for Chemistry* is provided as an insert with this question paper.
- This document consists of **12** pages. Any blank pages are indicated.

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

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Answer **all** the parts.

Introduction

In this experiment you will investigate the composition of a **mixture** of sodium hydroxide and sodium carbonate by carrying out a titration with hydrochloric acid.

The reactions take place in **two stages**:

- the end of the first stage is detected by use of phenolphthalein as an indicator;
- the end of the second stage is detected by use of methyl orange as an indicator.

You will use the two different indicators one after the other.

Four chemicals are provided.

- Solution **X** contains hydrochloric acid, HC*l*, of concentration 2.50 mol dm^{-3}. **Irritant** 
- Solution **Y** contains a mixture of sodium hydroxide, NaOH, and sodium carbonate, Na_2CO_3. **Irritant** 
- Phenolphthalein. **Flammable** 
- Methyl orange.

Part 1 Titration of solution Y
Skill I (Implementing) **[17 marks]**

You are advised to read the instructions before carrying out the procedure below. Record all your readings on page 3.

Using a pipette and filler, transfer 10.0 cm^3 of **X** into the 250 cm^3 volumetric flask.
Make the solution up to 250 cm^3 using distilled (or de-ionised) water.
Invert the volumetric flask several times before use, to mix the solution thoroughly.

Fill the burette with your **diluted** solution of **X**.
Record all burette readings to 0.05 cm^3.

Using a pipette and filler, transfer 25.0 cm^3 of **Y** into a conical flask.

For the **first stage** of the titration, add five drops of phenolphthalein indicator.
Carry out the first stage of the trial titration which is complete when the indicator changes from pale pink to colourless. The colour change occurs quite slowly. You should record the volume when the solution becomes completely colourless. Record your readings to obtain the titre for the first stage.

You must keep this colourless mixture for the second stage of the titration.

For the **second stage** of the titration, add five drops of methyl orange indicator to the mixture in the conical flask. The mixture will turn yellow.
Carry out the second stage of the titration which is complete when the indicator changes from orange to pink. Record your readings to obtain the **total titre**.

Repeat the two-stage titration to obtain **two** further sets of results.

You will only have time to carry out two accurate titrations.

Readings and calculations

Use the space below to record all your readings.

Calculate, showing your working:

- the mean titre, **A**, for the **first stage** of the titration;

- the mean **total titre**, **B**, for the titration;

- the difference, **C**, between these two titres.
  (This is the mean titre for the **second stage** of the titration.)

Safety

Water is the solvent in the solution of one of the indicators.
Ethanol is the solvent in the solution of the other indicator.
State and explain which indicator contains ethanol as its solvent.

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Part 2 Calculating the concentrations of NaOH and Na_2CO_3 in solution Y
Skill A (Analysis) **[13 marks]**

In all questions show your working and express your answers to **three** significant figures.

(a) Calculate the concentration of HC*l*, in mol dm^{-3}, in your **diluted** solution of **X**.

concentration = ...mol dm^{-3}

(b) Calculate the amount, in moles, of HC*l* used in **C**, the mean titre of the **second stage** of your titration.

amount = ...mol

(c) The sodium carbonate in **Y** reacts with hydrochloric acid in two stages.

- During the **first stage** of the titration, the following two reactions occur:

$$NaOH + HCl \longrightarrow H_2O + NaCl$$

$$Na_2CO_3 + HCl \longrightarrow NaHCO_3 + NaCl$$

- During the **second stage** of the titration, the following reaction occurs:

$$NaHCO_3 + HCl \longrightarrow NaCl + CO_2 + H_2O$$

Use your answer to **(b)** to deduce the amount, in moles, of $NaHCO_3$ that reacted in the **second stage** of the titration.

amount = ...mol

(d) Explain why the amount, in moles, of Na_2CO_3 that reacted in the **first stage** of the titration is equal to the amount, in moles, of $NaHCO_3$ you calculated in **(c)**.

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(e) **(i)** Calculate the concentration, in mol dm^{-3}, of Na_2CO_3 in solution **Y**.

concentration = ... mol dm^{-3}

(ii) Calculate the mass of Na_2CO_3 dissolved in 1.00 dm^3 of solution **Y**.

mass = ... g

(f) In the **first stage** of the titration, some of the HC*l* in the diluted solution of **X** reacted with NaOH in **Y**.

(i) Refer to your titration data on page 3.
Subtract **C** from **A**. This is the volume of the **diluted** solution of HC*l*, **X**, that reacts with the NaOH.

volume = ... cm^3

(ii) Use your answers to **f(i)** and **Part 2(a)** to calculate the amount, in moles, of HC*l* that reacts with the NaOH.

amount = ...mol

(iii) Calculate the concentration, in mol dm^{-3}, of NaOH in **Y**.

concentration = ...mol dm^{-3}

(iv) Calculate the mass of NaOH dissolved in 1.00 dm^3 of **Y**.

mass = ...g

Part 3 Skill E (Evaluating) **[14 marks]**

(a) (i) During the dilution of **X**, in **Part 1**, you used the following pieces of apparatus:

- volumetric flask (assume an accuracy of 0.2 cm^3);
- pipette (assume an accuracy of 0.03 cm^3).

Which piece of apparatus has the greater % accuracy?
Show calculations to justify your answer.

[3]

(ii) State and explain whether the procedure would have been more accurate if a burette had been used to measure the 10.0 cm^3 of **X** instead of a pipette.

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(b) Which of the titre values, **A** or **B**, that you determined was more **reliable**?
Use your titration data on page 3 to justify your answer.

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(c) You carried out a 'double indicator' titration that involved two indicators.

Suggest **two** reasons why the concentrations determined from this two-stage titration are less accurate than a concentration determined from a one-stage titration that uses only one indicator.

Justify your suggestions.

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(d) Solution **Y** contains a mixture of sodium hydroxide, NaOH, and sodium carbonate, Na_2CO_3. A student suggested that the concentration of NaOH in **Y** could be determined by making a single measurement of the pH of **Y** using a pH meter.

Suggest **and** explain why determination of the concentration of NaOH in **Y** by measuring the pH of **Y** would be inaccurate.

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END OF QUESTION PAPER

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