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Centre Number			Candidate Number									
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General Certificate of Education
June 2002
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY CHM3/P
Unit 3(b) Practical Examination

Wednesday 15 May 2002 9.00 am to 11.00 am

In addition to this paper you will require:
the AQA Periodic Table (Reference CHEM/PT/EX);
a calculator.

Time allowed: 2 hours

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- **Carry out all three exercises**.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.
- Take careful note of all the instructions given in each exercise.

Information

- The use of note books and laboratory books is **not** permitted.
- The maximum mark for this paper is 30.
- The skills which are being assessed are
  Skill 1 Planning (8 marks) Exercise 3
  Skill 2 Implementing (8 marks) Exercise 1
  Skill 3 Analysing (8 marks) Exercise 2
  Skill 4 Evaluating (6 marks) Exercise 2
- This paper carries 15 per cent of the total marks for AS. For Advanced Level this paper carries $7\frac{1}{2}$ per cent of the total marks.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.

Advice

- You are advised to spend approximately 30 minutes on Exercise 1, 45 minutes on Exercise 2 and 45 minutes on Exercise 3.
- You are advised to carry out Exercise 1 first.

For Examiner's Use			
Number	Mark	Number	Mark
Skill 1			
Skill 2			
Skill 3			
Skill 4			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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This paper consists of the following.

Exercise 1	**Implementing**	Determination of the concentration of a solution of hydrochloric acid.
Exercise 2	**Analysing and Evaluating**	Determination of the water of crystallisation in a sample of sodium carbonate.
Exercise 3	**Planning**	Determination of the enthalpy change of a metal displacement reaction.

An essential part of any practical work is to plan for the most efficient use of the time available. There is enough time to complete the exercises set provided that a sensible approach is used.

You are advised to spend approximately

30 minutes on Exercise 1
45 minutes on Exercise 2
45 minutes on Exercise 3.

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Exercise 1 Determination of the concentration of a solution of hydrochloric acid

Skill assessed: Implementing (8 marks)

Introduction

You are provided with a solution of hydrochloric acid whose concentration is approximately 1 mol dm^{-3}. Determine the exact concentration of the hydrochloric acid solution as follows:

- Prepare a diluted solution of the hydrochloric acid.
- Titrate this diluted solution with sodium hydroxide solution of concentration 0.100 mol dm^{-3}.

Wear safety glasses at all times.

Procedure

1. Rinse a pipette with the hydrochloric acid solution provided. Using this pipette and filler, transfer 25.0 cm^3 of the hydrochloric acid solution provided to a 250 cm^3 graduated volumetric flask and make the liquid level up to the mark with distilled or de-ionised water.
   Have the total volume of your solution checked by the supervisor before starting to mix the contents of the flask thoroughly.

2. Rinse the burette with the **diluted** hydrochloric acid solution. Set up the burette and, using a funnel, fill it with the **diluted** hydrochloric acid solution.

3. Rinse a pipette with the sodium hydroxide solution provided. Using this pipette and filler, transfer 25.0 cm^3 of the sodium hydroxide solution to a 250 cm^3 conical flask. Add 2 or 3 drops of screened methyl orange indicator.

4. Add the acid from the burette until the mixture in the conical flask turns purple/grey; record your results in the table below.

5. Rinse the conical flask with distilled or de-ionised water and repeat the titration until you obtain **two** titres which are within 0.10 cm^3 of each other. (You should not do more than five titrations.)

6. Calculate and record the average titre.

Final burette reading/cm^3					
Initial burette reading/cm^3					
Volume of hydrochloric acid solution used/cm^3					
Tick the titres to be used in calculating the average					

Average titre ..... cm^3

For Examiner's use only					
M		C		P	
T		A			

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Exercise 2 Determination of the water of crystallisation in a sample of sodium carbonate.

Skills assessed: **Analysing** (8 marks) and **Evaluating** (6 marks)

Introduction

A sample of sodium carbonate was known to be the monohydrate, $Na_2CO_3.H_2O$ A trainee chemist was asked to confirm the identity of the sample by titration of a solution of the sodium carbonate with hydrochloric acid.

The chemist rinsed a weighing bottle with de-ionised water and transferred sodium carbonate to the bottle until 0.25 g had been added. The contents of the weighing bottle were then tipped into a conical flask. About 30 cm^3 of deionised water were added to the conical flask, and the mixture was shaken until all of the sodium carbonate had dissolved.

The chemist filled a burette with 0.100 mol dm^{-3} hydrochloric acid. The sodium carbonate solution was titrated with the acid solution, using phenolphthalein as indicator.

The chemist then repeated the above procedure using further 0.25 g portions of the sodium carbonate sample. The following results were obtained.

Titration number	1	2	3	4	5
Final burette reading/cm^3	19.60	19.20	19.35	19.15	25.85
Initial burette reading/cm^3	0.05	0.05	0.05	0.10	6.75
Titre/cm^3					

Analysis

1. Under the conditions of the titration, sodium carbonate and hydrochloric acid react in a 1:1 mole ratio to form sodium hydrogencarbonate, $NaHCO_3$ Write an equation for the reaction, representing sodium carbonate as Na_2CO_3

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2. Use all of the concordant results in the table above to determine an average titre.

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3. Use the average titre to calculate the number of moles of sodium carbonate, Na_2CO_3, present in 0.25 g of the sample.

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4. Using your result from part 3, determine the relative molecular mass, M_r, of the hydrated sodium carbonate.

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5. Using your result from part 4, calculate the number of moles of water of crystallisation in one mole of hydrated sodium carbonate.

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6. Assume that the maximum errors for the apparatus used in this experiment were

balance total error	± 0.01 g
burette total error	± 0.15 cm^3 (from two readings and an end-point error)

Calculate the maximum percentage error in using the balance and the burette in this experiment, and hence the overall maximum percentage error.

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EXERCISE 2 CONTINUES ON THE NEXT PAGE

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Evaluation

1. Comment on the consistency of the titrations.

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2. Calculate the difference between the experimental M_r value determined by the chemist and the actual M_r value of $Na_2CO_3.H_2O$ Express this difference as a percentage of the actual M_r value of $Na_2CO_3.H_2O$

(If you could not complete the calculation in part 4 of the Analysis section, you should assume that the experimental M_r value is 133. This is **not** the correct answer.)

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3. Comment on the significance of the difference between the actual M_r of the hydrated sodium carbonate and your calculated value. Assume that this difference is **not** due to impurities.

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4. State **two** ways of improving the chemist's method of weighing out the sodium carbonate and explain why the accuracy of the experiment would be improved.

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Exercise 3 Determination of the enthalpy change of a metal-displacement reaction.

Skill assessed: Planning (8 marks)

Write your answer to this exercise in the space provided on pages 8 to 12 of this booklet.

Introduction

Zinc reacts with aqueous copper(II) sulphate in an exothermic reaction according to the following equation.

$$Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$$

Your task is to determine the enthalpy change of this reaction.

When using an excess of powdered zinc, the reaction is completed in about five minutes. Zinc sulphate and copper(II) sulphate solutions are potentially harmful.

Question

Using the information above, describe how you would determine the molar enthalpy change of the reaction between zinc and copper(II) sulphate. Assume that you have zinc powder, copper(II) sulphate solution of concentration 0.20 mol dm^{-3} and access to a balance that can weigh to the nearest 0.01 g.

Your answer must include

1. The volume of copper(II) sulphate solution to be used.

2. The choice of a suitable mass of zinc to be used, and your reasons for choosing this mass.

3. A description of the experiment you would perform, including details of the apparatus you would use and the precautions you would take to minimise heat loss.

4. A clear explanation, with diagrams and graphs as appropriate, showing how you would use your results for the reaction to calculate the molar enthalpy change of the reaction between zinc and copper(II) sulphate.

5. Details of the potential hazards, and the relevant safety precautions you would take.

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