OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY 2813/03/TEST

Practical Examination 1 (Part B – Practical Test)

Tuesday **18 JANUARY 2005** 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 an electronic 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 10 printed pages and 2 blank pages.

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Answer **all** the parts.

Introduction

The main aim of the experiments is to investigate the reaction between phosphoric(V) acid, H_3PO_4, and sodium hydroxide.
It is possible that this reaction could produce NaH_2PO_4, Na_2HPO_4 or Na_3PO_4.

Three chemicals are provided for the titration.

- Solution **G** is aqueous **sodium hydroxide** containing 4.40 g of NaOH in 1.00 dm^3 of solution.
- Liquid **H** is a concentrated aqueous solution of **phosphoric acid**, H_3PO_4.
- Phenolphthalein solution is the indicator.

Irritant

Corrosive

Flammable

Part 1 Titration of aqueous NaOH with aqueous H_3PO_4 Skill I (Implementing) [14 marks]

Record all your readings in the spaces on page 3.

Put approximately 20 cm^3 of distilled (or de-ionised) water into the volumetric flask provided.
Weigh the flask and water.

Ask your teacher to put about 1 cm^3 of phosphoric acid, **H**, into your volumetric flask.
Weigh the flask again with the phosphoric acid and water.

Make the mixture in the volumetric flask up to 250 cm^3 using distilled water.
Mix this solution thoroughly before using it for your titrations.

Fill the burette with aqueous NaOH, **G**.

Using a pipette and filler, transfer 25.0 cm^3 of your **diluted solution of H** into a conical flask.
Add about 3 drops of phenolphthalein indicator.

Carry out a rough/trial titration using solution **G** from the burette.
Read the burette to the nearest 0.05 cm^3.
The end-point is when the indicator changes from colourless to pale pink.

Now carry out the titration accurately and obtain **two** consistent values for the titre.
In each case, use 25.0 cm^3 of your **diluted solution of H**.

Note: keep the remainder of your diluted solution of **H** for use in **Part 3**.

Results

Use the spaces below to record **all** your readings.

Weighings

mass of **H** used = ... g

Titration data (tabulated)

Summary

25.0 cm^3 of the **diluted solution of H** required a mean titre of ..... cm^3 of solution **G**.

Show the readings you used to obtain this value of the volume of **G** by putting a tick (✓) under these readings.

Safety

State and explain what you would do if some concentrated phosphoric acid, **H**, splashed on to your hand.

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Part 2 Deducing the equation for the reaction of NaOH with H_3PO_4
Skill A (Analysing) **[12 marks]**

Use the *Data Sheet for Chemistry* supplied for any data you require.
In all parts involving calculations, your working must be shown clearly.
Give your answers to three significant figures, where appropriate.

(a) The phosphoric acid, **H**, you used was 85.0% pure by mass.
Calculate the mass of **pure** H_3PO_4 you weighed out.

answer = ... g

(b) Calculate the number of moles of H_3PO_4 in the 250 cm^3 of solution you made up.

answer = ... mol

(c) Calculate the number of moles of H_3PO_4 used in each titration.

answer = ... mol

(d) Solution **G** contained 4.40 g dm^{-3} of NaOH.
Calculate the concentration of NaOH, in mol dm^{-3}, in **G**.

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

(e) Calculate the number of moles of NaOH used in the mean titre.

answer = ... mol

(f) Use your answers to **(c)** and **(e)** to calculate how many moles of NaOH react with 1 mol of H_3PO_4. Show your working and give your answer to the nearest whole number.

answer = ... mol

(g) There are three possible reactions of NaOH with H_3PO_4, shown by the equations below.

$NaOH + H_3PO_4 \longrightarrow NaH_2PO_4 + H_2O$ ☐

$2NaOH + H_3PO_4 \longrightarrow Na_2HPO_4 + 2H_2O$ ☐

$3NaOH + H_3PO_4 \longrightarrow Na_3PO_4 + 3H_2O$ ☐

Put a tick (✓) next to the equation which corresponds most closely to your answer to **(f)**. Justify your answer.

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Part 3 Test tube reactions with aqueous phosphoric acid
Skills I and A (Implementing and Analysing) **[4 marks]**

Salts formed by phosphoric acid are called phosphates.
In these tests, you will investigate the solubility of two metal phosphates.

Pour some of your dilute aqueous phosphoric acid from the volumetric flask into a beaker. Use a 2 cm depth in two separate test tubes.

(a) Add a few drops of aqueous silver nitrate to the first test tube. **Irritant** 

Record the observation made, if any, below.

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Is silver phosphate soluble in water? Explain your answer.

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(b) Add a few drops of aqueous lead nitrate to the second test tube. **Toxic** 

Record the observation made, if any, below.

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Is lead phosphate soluble in water? Explain your answer.

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Part 4 Skill E (Evaluating) **[14 marks]**

(a) Why should the diluted solution of phosphoric acid in the volumetric flask be shaken thoroughly before using it for the titration?

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(b) State **two** advantages of doing a trial titration before carrying out the accurate ones.

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(c) It is important that solutions of sodium hydroxide, such as **G**, are supplied in stoppered bottles. This is to prevent the reaction of sodium hydroxide with an acidic gas present in air.
Suggest which gas in air would react with sodium hydroxide and give a balanced equation for the reaction.

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(d) (i) Some 25.0 cm^3 pipettes are calibrated to within 0.06 cm^3.
Calculate the possible percentage error when such a pipette is used.

answer = ... % [2]

(ii) Assume that the balance you used was accurate to within 0.01 g. The balance was used twice to determine the mass of phosphoric acid, **H**. Comment on the significance of the percentage errors associated with using the balance and the pipette in this experiment.

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(e) Another student carried out a similar titration to obtain more evidence about the reaction taking place between phosphoric acid and sodium hydroxide. She used 0.00300 mol of NaOH to neutralise the phosphoric acid.

The student calculated the mass of crystals that would be expected from each of the three possible reactions shown in **Part 2 (g)** on page 5. The masses of crystals expected according to the first two equations are given below.

$$NaOH + H_3PO_4 \longrightarrow \underset{0.36\,g}{NaH_2PO_4} + H_2O$$

$$2NaOH + H_3PO_4 \longrightarrow \underset{0.21\,g}{Na_2HPO_4} + 2H_2O$$

(i) Calculate the mass of crystals that would be expected from the third possible reaction, below.

$$3NaOH + H_3PO_4 \longrightarrow Na_3PO_4 + 3H_2O$$

[2]

(ii) After the titration, the student allowed the contents of the titration flask to evaporate completely at room temperature for several days. At the end of that time, 0.54 g of colourless crystals were obtained at the bottom of the flask.

Comment on the student's result and suggest a possible reason for it.

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END OF QUESTION PAPER

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