OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

CHEMISTRY 2816/03/TEST

Practical Test (Part B)

Wednesday **22 MAY 2002** Morning 1 hour 30 minutes

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

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

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

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.
- Use of the *Data Sheet* for *Chemistry* is allowed.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
Planning	16	
1	14	
2	16	
3	14	
TOTAL	60	

This question paper consists of 6 printed pages and 2 lined pages.

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Introduction

Some organic compounds can be identified by determination of their relative molecular masses. In the case of carboxylic acids this can be done using a titration.

In this experiment, you will determine the relative molecular mass of a carboxylic acid whose formula can be represented as H_2X. This acid is a reducing agent.
You will carry out a redox titration using potassium manganate(VII).

Two chemicals are provided.

- **Y** is a solution of potassium manganate(VII), $KMnO_4$, containing 3.50 g dm^{-3} of solid.
- H_2X is a sample of the carboxylic acid.

Skill I (Implementing) [14 marks]

(a) Weigh the bottle provided containing the acid, H_2X.
Tip **all** the solid H_2X into a beaker, and weigh the empty bottle.
Record the masses and all your other readings on page 3 of this booklet.

(b) Dissolve your solid H_2X carefully in about 100 cm^3 of distilled (or deionised) water. Stir to speed up the process.
When all of the solid has dissolved, make the solution up to 250 cm^3 in a volumetric flask using distilled water.
Remember to mix this solution thoroughly before using it for your titrations.

(c) Using a pipette and filler, transfer 25.0 cm^3 of your solution of H_2X into a conical flask.
Add about 20 cm^3 of dilute sulphuric acid, using a measuring cylinder.
Put the conical flask and its contents on a tripod and gauze and heat them up to 60–70 °C. Then remove the Bunsen burner.
Check the temperature of the mixture with a thermometer, but do not leave the thermometer in the conical flask during the titration.
Wash the end of the thermometer with a **little** distilled water.
Remove the **hot** conical flask **carefully** from the tripod and gauze in order to titrate its contents. **Hold the flask in a suitable way while moving it.**

(d) Fill the burette with aqueous potassium manganate(VII), **Y**, provided.
Record burette readings to 0.05 cm^3.
Carry out a trial titration.
Run in solution **Y** from the burette, quite slowly at first.
At the end-point, the colourless solution in the conical flask turns a **pale pink** colour which persists for several seconds.
Record all your readings in a suitable table on page 3.

If a permanent brown precipitate develops, your temperature was too low.
Stop the titration and start again with a fresh 25.0 cm^3 portion of acid H_2X.

(e) Now carry out the titration accurately, and repeat it to obtain two values for the titre. In each case use 25.0 cm^3 of the solution of H_2X.
You will not have time to carry out more than two accurate titrations.

Work out the mean titre. Show which readings you used to work out the mean titre by placing a tick under the readings used.

Use the space below to write down all your readings.

State and explain **one** safety precaution you took while doing the experiment.

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For Examiner's Use

Skill A (Analysing evidence and drawing conclusions) [16 marks]

You are advised to show full working in all parts of your calculations.

(a) Calculate the concentration, in mol dm^{-3}, of $KMnO_4$ in **Y**.
Remember that **Y** contains 3.50 g dm^{-3} of $KMnO_4$.
Then calculate the amount, in moles, of $KMnO_4$ used in your mean titre.

(b) The ionic half-equation for the oxidation of acid $\mathbf{H_2X}$ during the reaction is

$$H_2X \longrightarrow 2H^+ + X + 2e^-$$

During the titration, MnO_4^- is reduced in acid solution to Mn^{2+}.
Work out the ionic half-equation for the reduction of the manganate(VII) ion.
Hence show that 1 mol of MnO_4^- oxidises 2.5 mol of $\mathbf{H_2X}$.

(c) Calculate the amount, in moles, of H_2X which reacted with $KMnO_4$ in the mean titration. Then calculate the number of moles of H_2X dissolved in 250 cm^3 of solution in the volumetric flask.

(d) Hence, calculate the relative molecular mass of H_2X.

(e) The structural formula of H_2X is $(COOH)_2.wH_2O$. Deduce the value of **w**, the number of moles of water of crystallisation in one mole of H_2X.

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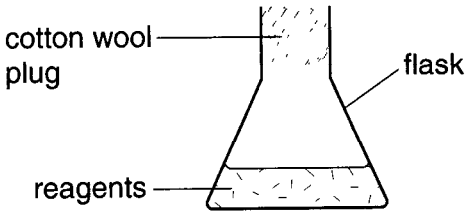
Skill E (Evaluating evidence and procedures) [14 marks]

Information

The relative molecular mass of acid H_2X was determined by a different method.
H_2X is a dibasic (diprotic) acid.
A solution of H_2X was made, using weighed quantities of the acid and water.
This solution was allowed to react with excess sodium hydrogen carbonate, $NaHCO_3$, which was also weighed before use.

$$HCO_3^- + H^+ \longrightarrow CO_2 + H_2O$$

The reaction was carried out in a conical flask. As soon as the chemicals had been mixed, a loose-fitting plug of cotton wool was put into the neck of the flask.



When fizzing ceased, the flask and its contents were re-weighed.

Readings

Mass of conical flask (empty) with cotton wool	= 78.54 g
Mass of solid H_2X used	= 5.20 g
Mass of water used to dissolve H_2X	= 100.00 g
Mass of sodium hydrogen carbonate added	= 10.50 g
Total mass of flask, cotton wool and all contents at the end of the reaction	= 191.02 g

Questions

(a) Use these data to:

(i) calculate the amount, in moles, of CO_2 released;

(ii) deduce the amount, in moles, of H_2X used;

(iii) calculate the relative molecular mass of H_2X.

Show your working clearly.

(b) Why was a cotton wool plug used in the conical flask?

(c) Discuss whether the result from this experiment would be more or less reliable if the chemicals were heated gently during the reaction. Explain your answer.

(d) This experiment gives a larger value for the relative molecular mass of H_2X than the titration method you carried out. Identity three sources of inaccuracy for the experiment involving sodium hydrogen carbonate.