OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY 2816/03/TEST

Practical Examination 2 (Part B – Practical Test)

Thursday **25 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 the 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.
- You will be awarded marks for the quality of written communication where this is indicated.

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

This question paper consists of 11 printed pages and 1 blank page.

Registered Charity Number: 1066969
[Turn over

Introduction

In **Part 1**, you will carry out a titration using aqueous potassium dichromate(VI) to determine the value of ***x*** in hydrated iron(II)ammonium sulphate, $FeSO_4(NH_4)_2SO_4.xH_2O$.
In **Part 2**, you will calculate the value of ***x***.
In **Part 3**, you will carry out two tests with aqueous potassium dichromate(VI).

Part 1 Titration of aqueous potassium dichromate(VI) with aqueous iron(II) ammonium sulphate

Skill I (Implementing) **[12 marks]**

Five chemicals are supplied.

- **F** Hydrated iron(II) ammonium sulphate, $FeSO_4(NH_4)_2SO_4.xH_2O$. **Harmful** 
- **G** Aqueous potassium dichromate(VI), $K_2Cr_2O_7$, containing 5.00 g of solid dissolved in 1.00 dm^3 of solution. **Irritant** 
- **H** Aqueous sulphuric acid. **Irritant** 
- **J** Aqueous phosphoric acid. **Corrosive** 
- **K** Aqueous barium diphenylamine sulphonate (indicator). **Irritant** 

Record all your readings on page 3.

Weigh the bottle provided containing **F**.
Transfer all of **F** into a 250 cm^3 beaker.
Weigh the empty bottle.
Calculate the mass of **F** used.

Dissolve **F** in a mixture of about 100 cm^3 of distilled (or deionised) water and about 20 cm^3 of **H**.
Transfer this solution carefully to a 250 cm^3 volumetric flask.
Add distilled or deionised water to make up the solution to exactly 250 cm^3.
Shake the solution thoroughly before using it.

Using a pipette and filler, transfer 25.0 cm^3 of your solution of **F** into a 250 cm^3 conical flask.
Then add to the same conical flask:

- about 20 cm^3 of **H**, using a measuring cylinder;
- about 20 cm^3 of **J**, using the same measuring cylinder;
- about 10 drops of indicator, **K**.

Fill the burette with **G**.
Record all burette readings to 0.05 cm^3 in a table on page 3.

Carry out a trial titration.
The colour change at the end point is from green/grey to purple/violet.
Use the trial titration to familiarise yourself with this colour change.

Repeat the titration procedure twice to obtain **two** accurate titres.
In each case, add 20 cm^3 of **H**, 20 cm^3 of **J** and 10 drops of **K** to the 25.0 cm^3 portion of aqueous iron(II) ammonium sulphate in the conical flask.
You will not have time to carry out more than two accurate titrations.

Readings

Use the space below to record all your readings.
Calculate the mass of **F** used and the mean titre.

Safety

State and explain what you would do if several drops of the aqueous phosphoric acid, **J**, splashed on to your hand.

.....

.....

.....

.....

Part 2 Calculating the value of *x* in the formula of $FeSO_4(NH_4)_2SO_4.xH_2O$
Skill A (Analysing) **[11 marks]**

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

(a) Solution **G** contains 5.00 g of $K_2Cr_2O_7$ dissolved in 1.00 dm^3 of solution.
Calculate the concentration of $K_2Cr_2O_7$, in mol dm^{-3}, in solution **G**.

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

(b) Calculate the amount, in moles, of $K_2Cr_2O_7$ used in your mean titre.

answer = ... mol

(c) During the titration, dichromate(IV) ions $Cr_2O_7^{2-}$ are reduced to Cr^{3+} ions in acidic conditions.

Balance the ionic half-equation for this reduction.

$$Cr_2O_7^{2-} + H^+ + e^- \rightarrow Cr^{3+} + H_2O$$

(d) During the titration, Fe^{2+} ions are oxidised to Fe^{3+} ions.

Write down the ionic half-equation for this oxidation.

(e) Use your ionic half-equations in **(c)** and **(d)** to show that 1 mol of $Cr_2O_7^{2-}$ ions in potassium dichromate(VI) reacts with 6 mol of Fe^{2+} ions in iron(II) ammonium sulphate.

(f) Calculate the amount, in moles, of $FeSO_4(NH_4)_2SO_4.\boldsymbol{x}H_2O$ used in each titration.

answer = ... mol

(g) Calculate the relative formula mass of $FeSO_4(NH_4)_2SO_4.\boldsymbol{x}H_2O$.
You will need to use the mass of **F** that you weighed out and your answer to **(f)**.

answer = ...

[Turn over

(h) Calculate ***x***, the number of moles of water of crystallisation in 1 mole of **F**, $FeSO_4(NH_4)_2SO_4.$ ***x***H_2O.

*Note: if you were unable to calculate the relative formula mass of **F**, assume it to be 380 so that you can attempt part (h).*

answer, ***x*** = ...

Part 3 Test tube tests using aqueous potassium dichromate(VI)
Skills I and A (Implementing and Analysing) **[7 marks]**

You will carry out tests on two organic solids, **R** and **S**.

(a) **R** contains a carbonyl group, C=O.

Add about a 1 cm depth of aqueous sulphuric acid, **H**, into a test tube.
Add an equal volume of aqueous potassium dichromate(VI), **G** to the test tube.
Add a spatula measure of **R** to the test tube.

Using a test tube holder, heat this mixture gently, until it **just** begins to boil.
Then remove the test tube from the Bunsen flame and place it in the test tube rack.
Leave the test tube to stand for about one minute.

- Record the observation made, if any.
- What **type** of compound is **R**?
- Explain your reasoning.

.....

.....

.....

.....

.....

(b) **S** is an **alcohol** containing **six** carbon atoms.

Add about a 1 cm depth of aqueous sulphuric acid, **H**, into a test tube.
Add an equal volume of aqueous potassium dichromate(VI), **G** to the test tube.
Add a spatula measure of **S** to the test tube.

Using a test tube holder, heat this mixture gently, until it **just** begins to boil.
Then remove the test tube from the Bunsen flame and place it in the test tube rack.
Leave the test tube to stand for about one minute.

- Record the observation made, if any.
- What **type** of alcohol is **S**? Justify your answer.
- Give a **possible** structural or displayed formula for **S**.

.....

.....

.....

.....

.....

.....

[Turn over

Part 4 Skill E (Evaluating) [14 marks]

Information

A student decided to carry out a second experiment to confirm the relative formula mass of hydrated iron(II) ammonium sulphate, $FeSO_4(NH_4)_2SO_4.xH_2O$.

When a compound containing ammonium ions is heated gently with aqueous alkali, such as sodium hydroxide, ammonia gas is given off.

$$NH_4^+ + OH^- \longrightarrow NH_3 + H_2O$$

The student set up the apparatus shown below.
He heated hydrated iron(II) ammonium sulphate gently with aqueous sodium hydroxide and a gas was collected in the gas syringe.

A diagram has been removed due to third party copyright restrictions

Details: A diagram of some apparatus. A test tube containing hydrated iron (II) ammonium sulphate and aqueous sodium hydroxide is heated and the gas is collected in a gas syringe

The student carried out the experiment three times.
Each time he used 0.0040 mol of $FeSO_4(NH_4)_2SO_4.xH_2O$.
The alkaline solution he used contained 0.0060 mol of NaOH.
When the reaction was complete, the gas was cooled to room temperature.
The volumes of gas collected were 18, 25 and 22 cm^3 respectively.

In the boiling tube, a green precipitate was produced during the experiments.

One mole of gas occupies 24.0 dm^3 at room temperature and pressure, r.t.p.

Questions

(a) The ammonium ions in 0.0040 mol of $FeSO_4(NH_4)_2SO_4.\boldsymbol{x}H_2O$ reacted with sodium hydroxide.
Calculate the maximum volume of ammonia, measured in cm^3 at r.t.p., that can be produced by the reaction. [3]

answer = ... cm^3

(b) State **and** explain **three** reasons why the volume of gas collected by the student was much lower than the theoretical amount that you calculated in **(a)**.
In each case, suggest improvements to his procedure that would make the determination more accurate.
Explain why each of your improvements would reduce the error. [6]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[Turn over

(c) Why was your determination of the relative formula mass by titration more **reliable** than the gas collection experiment used by the student? [2]

.....

.....

.....

.....

(d) During the titration procedure, you used the following pieces of apparatus:

- 250 cm^3 volumetric flask (accurate to 0.3 cm^3)
- 25 cm^3 pipette (accurate to 0.06 cm^3).

Carry out calculations to decide which piece of apparatus has the lower % error. [3]

END OF QUESTION PAPER

BLANK PAGE