Centre Number | Candidate Number

Candidate Name ______________________________

CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CHEMISTRY 9701/3

PAPER 3 Practical Test

OCTOBER/NOVEMBER SESSION 2002

1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
As listed in Instructions to Supervisors
Electronic calculator and/or Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You may use a calculator.

You are advised to show all working in calculations.

Use of a Data Booklet is unnecessary.

Qualitative analysis notes are printed on pages 6 and 7.

FOR EXAMINER'S USE	
1	
2	
TOTAL	

This question paper consists of 7 printed pages and 1 blank page.

SP (SM) S25940/2

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

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1 **FA 1** is a hydrated metal sulphate, $XSO_4.7H_2O$.

You are required to determine the mass of water of crystallisation (the $7H_2O$ in the formula above) in a weighed sample of **FA 1** and to calculate the relative atomic mass, A_r, of the element **X**.

(a) Accurately weigh the hard glass test-tube provided. Record the mass in Table 1.1 below.

Add to the test-tube between 2.00 g and 2.50 g of **FA 1** and accurately weigh the test-tube and contents. Record this mass in Table 1.1 below.

Table 1.1 Mass of **FA 1**

Mass of test-tube + **FA 1**	/ g	
Mass of empty test-tube	/ g	
Mass of **FA 1**	/ g	

(b) Heat the test-tube, gently at first then strongly, to drive off the water of crystallisation. The crystals will 'crackle' at first as water is lost and 'steam' (condensed water vapour) will be seen coming out of the mouth of the tube.

If the crystals are overheated the sulphate can decompose and give off sulphur trioxide which will be seen as white fumes. If you see white fumes, do not confuse this with steam, stop heating.

Place the test-tube on a heat proof mat and leave to cool. Do **not** move about the laboratory with a hot test-tube.

(You are advised to continue with the second question while the tube cools.)

When cool, reweigh the test-tube and its contents. Record the mass in Table 1.2 below.

Table 1.2 Mass of **FA 1** after heating

Mass of test-tube + **FA 1** after heating	/ g	
Mass of empty test-tube (from Table 1.1)	/ g	
Mass of **FA 1** after heating	/ g	

(c) By repeating the heating, cooling and reweighing, show clearly by your results in Table 1.2 that all the water of crystallisation has been driven from the crystals, **FA 1**.

[4]

Accuracy [6]

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(d) Calculate

(i) the mass of anhydrous XSO_4 present in the crystals.

(ii) the mass of water driven from the crystals of **FA 1**.

[1]

(e) Calculate how many moles of water are present in the sample of **FA 1** used.
[A_r; H, 1.0; O, 16.0.]

[1]

(f) Use your answer to **(e)** and the formula $XSO_4.7H_2O$ to calculate how many moles of XSO_4 are present in the sample of **FA 1** used.

[1]

(g) Use your answers to **(d)** and **(f)** to calculate the relative molecular mass, M_r, of XSO_4.

[1]

(h) Calculate the relative atomic mass, A_r, of the element **X**.
[A_r; O, 16.0; S, 32.0.]

[1]

[Total : 15]

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2 The solution **FA 2** contains **two cations** and **two anions** from the following list: (Al^{3+}, NH_4^+, Ba^{2+}, Ca^{2+}, Cr^{3+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Pb^{2+}, Mg^{2+}, Mn^{2+}, Zn^{2+}; CO_3^{2-}, CrO_4^{2-}, Cl^-, Br^-, I^-, NO_3^-, NO_2^-, SO_4^{2-}, SO_3^{2-}).

In all tests, the reagent should be added gradually until no further change is observed, with shaking after each addition.
Record your observations and the deductions you make from them in the spaces provided.
Your answers should include

- details of colour changes and precipitates formed,
- the names of gases evolved and details of the test used to identify each one.

You should indicate clearly at what stage in a test a change occurs, writing any deductions you make alongside the observations on which they are based.

Marks are **not** given for chemical equations.
No additional or confirmatory tests for ions present should be attempted.

Candidates are reminded that definite deductions may be made from tests where there appears to be no reaction.

Test	*Observations* [5]	*Deductions* [4]
(a) Place 3 cm depth of **FA 2** in a boiling-tube, add an equal depth of dilute aqueous sodium hydroxide. **Cautiously** warm the tube.		
(b) Filter the mixture from **(a)** and collect the filtrate. Leave the residue in the filter paper and observe it again after several minutes.		
(c) Place 2 cm depth of the filtrate from **(b)** in a test-tube and add dilute nitric acid, drop by drop, until no further change is seen.		

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Test	Observations	Deductions
(d) Place 2 cm depth of the filtrate from **(b)** in a boiling-tube. Add a piece of aluminium foil. **Cautiously** warm the tube.		
(e) Place 3 cm depth of **FA 2** in a test-tube, add an equal depth of dilute aqueous ammonia. **Cautiously** warm the tube. Filter the mixture. Add dilute nitric acid, drop by drop, to the filtrate until no further change is seen.		
(f) Place 2 cm depth of **FA 2** in a test-tube, add dilute hydrochloric acid, followed by aqueous barium chloride.		
(g) Place 2 cm depth of **FA 2** in a test-tube, add dilute nitric acid, followed by aqueous silver nitrate.		

Summary

The cations present in **FA 2** are …………… and ……………

The anions in **FA 2** are …………… and ……………

[1]

[Total : 10]

QUALITATIVE ANALYSIS NOTES

[Key: ppt. = precipitate.]

1 Reactions of aqueous cations

	reaction with	
	$NaOH(aq)$	$NH_3(aq)$
aluminium, $Al^{3+}(aq)$	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, $NH_4^+(aq)$	ammonia produced on heating	
barium, $Ba^{2+}(aq)$	no ppt. (if reagents are pure)	no ppt.
calcium, $Ca^{2+}(aq)$	white ppt. with high [Ca^{2+} (aq)]	no ppt.
chromium(III), $Cr^{3+}(aq)$	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), $Cu^{2+}(aq)$	pale blue ppt. insoluble in excess	blue ppt. soluble in excess giving dark blue solution
iron(II), $Fe^{2+}(aq)$	green ppt. insoluble in excess	green ppt. insoluble in excess
iron(III), $Fe^{3+}(aq)$	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
lead(II), $Pb^{2+}(aq)$	white ppt. soluble in excess	white ppt. insoluble in excess
magnesium, $Mg^{2+}(aq)$	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), $Mn^{2+}(aq)$	off-white ppt. insoluble in excess	off-white ppt. insoluble in excess
zinc, $Zn^{2+}(aq)$	white ppt. soluble in excess	white ppt. soluble in excess

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate(VI), CrO_4^{2-}(aq)	yellow solution turns orange with H^+(aq); gives yellow ppt. with Ba^{2+}(aq); gives bright yellow ppt. with Pb^{2+}(aq)
chloride, Cl^-(aq)	gives white ppt. with Ag^+(aq) (soluble in NH_3(aq)); gives white ppt. with Pb^{2+}(aq)
bromide, Br^-(aq)	gives cream ppt. with Ag^+(aq) (partially soluble in NH_3(aq)); gives white ppt. with Pb^{2+}(aq)
iodide, I^-(aq)	gives yellow ppt. with Ag^+(aq) (insoluble in NH_3(aq)); gives yellow ppt. with Pb^{2+}(aq)
nitrate, NO_3^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil
nitrite, NO_2^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil, NO liberated by dilute acids (colourless NO $\rightarrow$ (pale) brown NO_2 in air)
sulphate, SO_4^{2-}(aq)	gives white ppt. with Ba^{2+}(aq) or with Pb^{2+}(aq) (insoluble in excess dilute strong acid)
sulphite, SO_3^{2-}(aq)	SO_2 liberated with dilute acids; gives white ppt. with Ba^{2+}(aq) (soluble in excess dilute strong acid)

3 Tests for gases

gas	*test and test result*
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	‘pops’ with a lighted splint
oxygen, O_2	relights a glowing splint
sulphur dioxide, SO_2	turns potassium dichromate(VI) (aq) from orange to green

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