UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Subsidiary Level and Advanced Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **9701/32**

Paper 32 Practical Test **October/November 2007**

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Instructions to Supervisors

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Give details of the practical session and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
You are advised to show all working in calculations.
Use of a Data Booklet is unnecessary.

Qualitative Analysis Notes are printed on pages 11 and 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Session
Laboratory

For Examiner's Use	
1	
2	
Total	

This document consists of **12** printed pages.

UNIVERSITY *of* CAMBRIDGE International Examinations

[Turn over

1 **Read through question 1 before starting any practical work.**

You are provided with the following reagents.

FB 1, 1 mol dm^{-3} sulphuric acid, H_2SO_4
FB 2, 0.1 mol dm^{-3} potassium iodide, KI
FB 3, 0.1 mol dm^{-3} sodium thiosulphate, $Na_2S_2O_3$
FB 4, 0.1 mol dm^{-3} hydrogen peroxide, H_2O_2
starch solution
distilled water

In the presence of an acid, iodide ions are oxidised by hydrogen peroxide to iodine.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \longrightarrow 2H_2O(l) + I_2(aq)$$

The rate of reaction can be followed by timing the formation of a fixed amount of iodine in the solution.

If sodium thiosulphate is present in the reaction mixture it reacts with the iodine formed and the solution remains colourless.

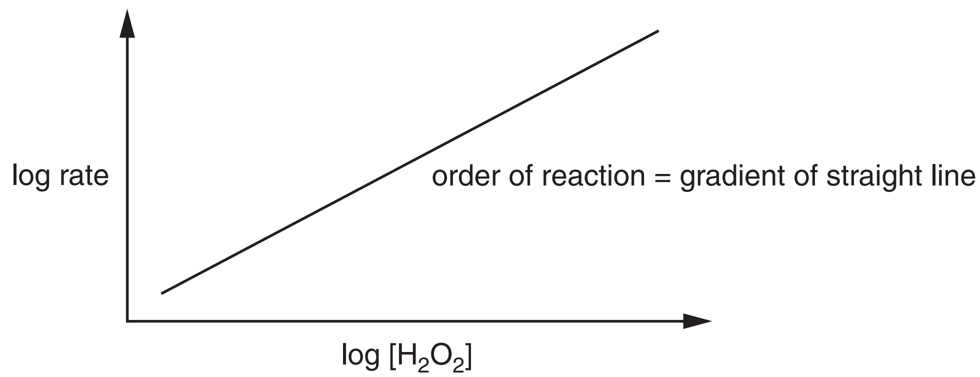
$$I_2(aq) + 2S_2O_3^{2-}(aq) \longrightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

When all of the sodium thiosulphate present has reacted, iodine, I_2, will appear in the solution producing an immediate blue colour with starch indicator.

In a series of experiments where the concentration of a reagent is changed

- 1/time can be used as a measure of rate,
- the volume of the reagent used can be taken as a measure of its concentration providing the total volume of the mixture is kept constant in each experiment.

The order of reaction with respect to hydrogen peroxide can be obtained by plotting a graph of log rate against log $[H_2O_2]$.



For Examiner's Use

(a) Method

Experiment 1

- Fill the burette **labelled FB 3** with **FB 3** and the burette **labelled FB 4** with **FB 4**.
- Use the measuring cylinder **labelled A** to put the following solutions into a 250 cm^3 conical flask:
  20 cm^3 of **FB 2**, potassium iodide,
  20 cm^3 of distilled water.
- Add to the flask from the burette 1.00 cm^3 of **FB 3**, sodium thiosulphate.
- Add six drops of starch indicator to the mixture in the flask.
- Run 20.00 cm^3 of **FB 4**, hydrogen peroxide, from the second burette into a 100 cm^3 beaker.
- Use the measuring cylinder **labelled B** to add 20 cm^3 of **FB 1**, sulphuric acid, to the hydrogen peroxide in the beaker.
- Tip the contents of the beaker into the conical flask and **immediately** start a stop-clock or note the start time on a clock with a second hand.
- Swirl the flask to mix the reagents.
- Observe the solution and stop the clock or note the time when the solution suddenly turns blue.
- Record the time taken to the nearest second.

The time taken is .... s.

Experiment 2

- Empty, thoroughly rinse and drain the conical flask used in experiment 1.
- Use the measuring cylinder **labelled A** to put the following solutions into the 250 cm^3 conical flask:
  20 cm^3 of **FB 2**, potassium iodide,
  35 cm^3 of distilled water.
- Add to the flask from the burette 1.00 cm^3 of **FB 3**, sodium thiosulphate.
- Add six drops of starch indicator to the mixture in the flask.
- Run 5.00 cm^3 of **FB 4**, hydrogen peroxide, from the second burette into a 100 cm^3 beaker.
- Use the measuring cylinder **labelled B** to add 20 cm^3 of **FB 1**, sulphuric acid, to the hydrogen peroxide in the beaker.
- Tip the contents of the beaker into the conical flask and **immediately** start a stop-clock or note the start time on a clock with a second hand.
- Swirl the flask to mix the reagents.
- Observe the solution and again stop the clock or note the time when the solution suddenly turns blue.
- Record the time taken to the nearest second.

The time taken is .... s.

[2]

For Examiner's Use

(b) In experiment 1 you will have obtained the time taken for a 'fast' reaction and in experiment 2 the time taken for a 'slow' reaction.

You are to repeat the experiment with further mixtures in which **only** the concentration of hydrogen peroxide is varied.
In selecting the mixtures to be used you should consider

- how many mixtures need to be used,
- what concentrations of hydrogen peroxide should be used,
- what range these concentrations should cover,
- that only the concentration of hydrogen peroxide must change.

Remember – you already have reaction times for two mixtures with different concentrations of hydrogen peroxide.

In the space below prepare to record, in an appropriate form, the results of the experiments you will perform and the results of experiments 1 and 2.

Your recorded results should include calculated values to enable you to plot

log (1/time) against **log (volume of FB 4)**.

Carry out the additional experiments and record your results.

i	
ii	
iii	
iv	
v	
vi	
vii	
viii	
ix	
x	
xi	

[11]

For Examiner's Use

(c) Use the grid below to plot a graph of **log (1/time)** against **log (volume of FB 4)**.
Draw an appropriate straight line through the points plotted.

[4]

[Turn over

(d) Draw construction lines on your graph and obtain data from them to enable you to calculate the gradient of the graph.

Calculate the gradient of the line drawn, which is the order of reaction with respect to hydrogen peroxide.

The reaction is .... order with respect to hydrogen peroxide, H_2O_2. [3]

(e) In experiment 1 burettes and measuring cylinders were used to measure volume.

A burette is graduated to 0.10 cm^3 and is usually read to the nearest 0.05 cm^3.
A 25 cm^3 measuring cylinder is graduated to 0.5 cm^3.

Estimate the error when measuring a volume of 20 cm^3 in a 25 cm^3 measuring cylinder.

The error is ± ……………………… cm^3.

Use this answer and the information above to calculate the percentage error for each volume measurement made in experiment 1. Complete the table below.

solution	apparatus used	volume / cm^3	error / cm^3	% error
FB 1, **FB 2**, distilled water	25 cm^3 measuring cylinder	20		
FB 3	burette	1.00		
FB 4	burette	20.00		

Identify the most significant source of error in this experiment.

....

....[3]

(f) The experimental method can be modified to enable the rate of reaction with respect to iodide ions, I^-, to be investigated.

You will perform two further experiments **using the method for experiment 1 in section (a).** You will keep the concentration of hydrogen peroxide constant and **reduce** the concentration of iodide ions.

First copy your reaction time from experiment 1 in section **(a)** into the table below. Then complete the table below to show the volumes of **FB 2** and distilled water you will use in these two further experiments.

Carry out each experiment as before and record the time taken in each case.

	volume **FB 1** (H_2SO_4) / cm^3	volume **FB 2** (KI) / cm^3	volume water / cm^3	volume **FB 3** ($Na_2S_2O_3$) / cm^3	volume **FB 4** (H_2O_2) / cm^3	reaction time / s
experiment 1 in section **(a)**	20	20	20	1.00	20.00	
experiment **i**	20			1.00	20.00	
experiment **ii**	20			1.00	20.00	

[1]

(g) Use the experimental results from the three experiments to draw a conclusion as to how the rate of reaction is affected by changing the concentration of iodide ions.

....

....

....[1]

[Total: 25]

2 The three solutions **FB 5**, **FB 6**, and **FB 7 each** contain **one** of the following.

copper(II) chloride, $CuCl_2$

chromium(III) chloride, $CrCl_3$

nickel(II) sulphate, $NiSO_4$

(a) Use information from the Qualitative Analysis Notes on page 12 to select a pair of reagents that you could use to determine which solution contains the sulphate ion.

Carry out the tests and record, in the space below, the reagents used and the observations made.

From these tests, solution **FB** .... contains the sulphate ion.
[3]

(b) The solutions containing copper(II) and chromium(III) ions can be distinguished from one another by adding either aqueous sodium hydroxide or aqueous ammonia. Nickel(II) ions behave in a similar way to copper(II) ions with these reagents.

Add NaOH(aq) and NH_3(aq) separately to each of the solutions **FB 5**, **FB 6** and **FB 7**.

Record your observations in the space below.

From your observations in **(a)** and **(b)** identify the solutions containing copper(II) ions and chromium(III) ions.

Solution .... contains Cu^{2+}.

supporting evidence ....

....

Solution .... contains Cr^{3+}.

supporting evidence ....

....

[5]

(c) You are to perform the tests given in the table below on the solid **FB 8** and to comment on the type of compound present in **FB 8**.

Record details of colour changes seen, the formation of any precipitate and the solubility of any such precipitate in an excess of the reagent added.

Where gases are released they should be identified by a test, **described in the appropriate place in your table**.

You should indicate clearly at what stage in a test a change occurs.

Marks are **not** given for chemical equations.

No additional tests should be attempted.

test	observations with **FB 8**
(i) To 2 cm depth of distilled water in a boiling-tube, add 1 spatula measure of **FB 8**. Warm to dissolve the solid and immediately add a 1 cm length of magnesium ribbon.	
(ii) To 1 cm depth of aqueous sodium hydroxide in a test-tube, add 1 spatula measure of **FB 8**. Stir the mixture, then add 2 cm depth of dilute hydrochloric acid. Stir the mixture, then add 3 cm depth of aqueous sodium hydroxide.	

test	observations with **FB 8**
(iii) To 1 cm depth of ethanol in a **boiling-tube**, add 2 spatula measures of **FB 8** and a few drops of concentrated sulphuric acid **(CARE: corrosive)**. Heat the contents of the tube for 1-2 minutes, *using the apparatus provided for heating a flammable liquid* **(CARE)**. Pour the contents of the tube into a 100 cm^3 beaker full of water.	

From your observations, draw conclusions about the type of compound present in **FB 8**.

....

....

....
[7]

[Total: 15]

Qualitative Analysis Notes

Key: [ppt. = precipitate]

1 Reactions of aqueous cations

ion	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 A*l* foil
nitrite, NO_2^- (aq)	NH_3 liberated on heating with OH^-(aq) and A*l* 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