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

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

5508657271

CHEMISTRY **9701/34**

Advanced Practical Skills 2 **October/November 2012**

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

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 may lose marks if you do not show your working or if you do not use appropriate units.
Use of a Data Booklet is unnecessary.

Qualitative Analysis Notes are printed on pages 13 and 14.

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 **13** printed pages and **3** blank pages.

IB12 11_9701_34/5RP

UNIVERSITY of CAMBRIDGE International Examinations

[Turn over

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For Examiner's Use

1 You are to investigate how the rate of reaction between acidified hydrogen peroxide and aqueous iodide ions depends on the concentration of the hydrogen peroxide.

When hydrogen peroxide and potassium iodide are mixed in the presence of an acid, iodine, I_2, is produced and the colour of the solution changes from colourless to a blue-black colour if starch indicator is present.

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

If the reaction mixture contains sodium thiosulfate, the iodine produced in the reaction above is **immediately** reduced back to iodide ions. The solution only turns blue-black when all of the sodium thiosulfate has been used up.

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

FB 1 is 0.23 mol dm^{-3} hydrogen peroxide, H_2O_2.
FB 2 is 0.10 mol dm^{-3} potassium iodide, KI.
FB 3 is 0.050 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$.
FB 4 is 1.0 mol dm^{-3} sulfuric acid, H_2SO_4.
starch indicator
distilled water

Read through the instructions carefully before starting any practical work.

(a) Experiment 1

- Fill a burette with **FB 3**.
- Use the measuring cylinder labelled **A** to place 25 cm^3 of **FB 2** and 25 cm^3 of distilled water into a conical flask.
- Add to the conical flask 10.00 cm^3 of **FB 3** from the burette and 6 drops of starch indicator.
- Use the measuring cylinder labelled **B** to place 50 cm^3 of **FB 1** and 20 cm^3 of **FB 4** into a 100 cm^3 beaker.
- Pour the mixture from the beaker into the conical flask and **immediately** start timing.
- Swirl the flask to ensure good mixing and place the flask on a white tile.
- Stop timing when a blue-black colour suddenly appears in the solution.
- Record, in the table on page 4, the reaction time, in seconds, to the nearest second.
- Empty, rinse and drain the conical flask.

Experiment 2

- Use the measuring cylinder labelled **A** to place 25 cm^3 of **FB 2** and 35 cm^3 of distilled water into a conical flask.
- Add to the conical flask 10.00 cm^3 of **FB 3** from the burette and 6 drops of starch indicator.
- Use the measuring cylinder labelled **B** to place 40 cm^3 of **FB 1** and 20 cm^3 of **FB 4** into a 100 cm^3 beaker.
- Pour the mixture from the beaker into the conical flask and immediately start timing.
- Swirl the flask to ensure good mixing and place the flask on a white tile.
- Stop timing when a blue-black colour suddenly appears in the solution.
- Record, in the table on page 4, the reaction time, in seconds, to the nearest second.
- Empty, rinse and drain the conical flask.

Experiments 3 – 5

Carry out experiments 3 – 5 in the same way but using the volumes of solutions shown in the table.
Complete the units in the table.

Calculate all values of $\frac{(1000)}{(\text{reaction time})}$ to three significant figures.

Experiment	volume of **FB 2** / cm^3	volume of distilled water / cm^3	volume of **FB 3** / cm^3	volume of **FB 1** / cm^3	volume of **FB 4** / cm^3	reaction time	$\frac{(1000)}{(\text{reaction time})}$ ....
1	25	25	10.00	50	20		
2	25	35	10.00	40	20		
3	25	45	10.00	30	20		
4	25	55	10.00	20	20		
5	25	65	10.00	10	20		

I	
II	
III	
IV	
V	
VI	
VII	
VIII	
IX	

[9]

(b) The rate of reaction can be represented by the following formula.

$$\text{'rate'} = \frac{(1000)}{(\text{reaction time})}$$

On the next page plot a graph of **'rate'** against the **volume of FB 1**.

Start each of the axes at zero.

Draw the line of best fit.

For Examiner's Use

I	
II	
III	
IV	
V	

[5]

For Examiner's Use

(c) The concentration of hydrogen peroxide in **FB 1** is 0.23 mol dm^{-3}.

The total volume of each reaction mixture is 130 cm^3.

(i) Calculate the initial concentration of hydrogen peroxide for each of the following experiments. Show your working.

Experiment	volume of **FB 1** / cm^3	concentration of hydrogen peroxide / mol dm^{-3}
1	50	
5	10	

(ii) Use your results in **(i)** to show that the initial concentration of hydrogen peroxide is directly proportional to the volume of **FB 1** used in the experiment.

....

....

....

....

[3]

(d) A website states that the rate of reaction between acidified hydrogen peroxide and potassium iodide is **directly proportional** to the concentration of hydrogen peroxide.

Use your graph to decide whether the statement on the website is correct or not.

Explain your answer.

....

....

....

.... [2]

For Examiner's Use

(e) **Experiment 1** was repeated using 0.025 mol dm^{-3} sodium thiosulfate instead of **FB 3**. Suggest how this would affect the reaction time.
Explain your answer using the chemical equations on page 3.

....

....

....

.... [2]

(f) Suggest a factor, other than volumes of solutions used, that could have significantly affected the rate of reaction in each of the experiments.

.... [1]

(g) A student carrying out a similar investigation decides to repeat one of the experiments a number of times. The reaction times for these repeated experiments are listed below.

run	time / s
1	56
2	54
3	62
4	56
5	53

(i) From these experimental results calculate an appropriate mean reaction time, correct to 1 decimal place.

mean reaction time = ... s

(ii) Assume that the uncertainty in the mean reaction time is ±2 seconds.
Calculate this uncertainty as a percentage of the mean reaction time.

percentage uncertainty = ... %
[2]

(h) The experimental method you have used can be adapted to investigate how the rate of reaction would vary if the concentration of potassium iodide or the concentration of sulfuric acid were changed.

In the first line of the tables below, the volumes of **FB 2**, distilled water, **FB 3**, **FB 1** and **FB 4** used in **Experiment 2** are recorded.

Complete the following table, suggesting volumes for each of the reagents that could be used in a further experiment to investigate how the rate of reaction varies with a change in the volume of **potassium iodide**, **FB 2**.

Do not carry out this experiment.

Experiment	volume of **FB 2** / cm^3	volume of distilled water / cm^3	volume of **FB 3** / cm^3	volume of **FB 1** / cm^3	volume of **FB 4** / cm^3
2	25	35	10.00	40	20

Complete the following table, suggesting volumes for each of the reagents that could be used in a further experiment to investigate how the rate of reaction varies with a change in the volume of **sulfuric acid**, **FB 4**.

Do not carry out this experiment.

Experiment	volume of **FB 2** / cm^3	volume of distilled water / cm^3	volume of **FB 3** / cm^3	volume of **FB 1** / cm^3	volume of **FB 4** / cm^3
2	25	35	10.00	40	20

[1]

[Total: 25]

2 Qualitative Analysis

At each stage of any test you are to record details of the following.

- colour changes seen
- the formation of any precipitate
- the solubility of such precipitates 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 observations**.

You should indicate clearly at what stage in a test a change occurs.
Marks are **not** given for chemical equations.
No additional tests for ions present should be attempted.

If any solution is warmed, a boiling tube MUST be used.

Rinse and reuse test-tubes and boiling tubes where possible.

Where reagents are selected for use in a test, the name or correct formula of the element or compound must be given.

Solutions **FB 5**, **FB 6** and **FB 7** each contain one cation and one anion from those listed on pages 13 and 14.

Half fill a 250 cm^3 beaker with water. Heat the beaker and its contents to boiling then stop heating. You will need this as a hot water bath in **(f)**.

(a) Carry out the following tests on **FB 5**, **FB 6** and **FB 7** using aqueous sodium hydroxide.

- To 1 cm depth of **FB 5**, **FB 6** and **FB 7** in separate boiling tubes add 1 cm depth of aqueous sodium hydroxide.
- Shake the tube to mix the solutions then add a further 2 cm depth of aqueous sodium hydroxide.
- If **no** precipitate has formed in a solution for either of the previous steps, carefully **warm** the boiling tube and its contents.
  Care: if solutions containing sodium hydroxide are heated too strongly they may be ejected from the tube.

  Record your results in an appropriate form in the space below.

I	
II	
III	
IV	

[4]

(b) Carry out the following tests on **FB 5**, **FB 6** and **FB 7** using aqueous ammonia.

- To 1 cm depth of **FB 5**, **FB 6** and **FB 7** in separate test-tubes add 1 cm depth of aqueous ammonia.
- Shake the tube to mix the solutions then add a further 2 cm depth of aqueous ammonia.
- Record your results in an appropriate form in the space below.

[2]

(c) From your observations in **(a)** and **(b)**, identify the cation present in each of the following solutions.

solution	*cation*
FB 5	
FB 6	
FB 7	

[1]

(d) Each of the solutions **FB 5**, **FB 6** and **FB 7** contains either a sulfate or a sulfite anion.

(i) Which single reagent, when added to the solution, could confirm that either a sulfate or a sulfite is present?

....

Which additional reagent, when added to the same test-tube, would identify which of these two ions is present?

....

(ii) Carry out the tests on **FB 5**, **FB 6** and **FB 7** using the reagents you have selected and record your observations in the table below.

	observation		
	FB 5	**FB 6**	**FB 7**
reagent used:			
followed by:			

(iii) Identify the anion present in each solution. Explain your answer.

....

....

....
[4]

(e) Carry out the following test.

test	*observation*
To 1 cm depth of **FB 5** in a boiling tube, add 2 cm depth of the aqueous hydrogen peroxide, **FB 9**. Warm the tube, then,	
add 2 cm depth of aqueous sodium hydroxide.	

[2]

For Examiner's Use

(f) **Divide the sample of solid FB 8 in two**. Use one portion in each of the following tests.

Test 1

- Place the portion of **FB 8** in a boiling tube.
- Add 2 cm depth of dilute sulfuric acid.
- Warm with a Bunsen burner.
- Test any vapour evolved with litmus paper.

Observation ....

....

Test 2

- Reheat the water bath to boiling, then turn off the Bunsen burner.
- Place the remaining **FB 8** in a dry test-tube.
- Add 2 cm depth of ethanol.
- Use a dropping pipette to add 2 – 3 drops of concentrated sulfuric acid.
  Care – concentrated sulfuric acid is very corrosive.
- Warm the tube in the hot-water bath.
- After 3 – 4 minutes of warming tip the contents of the test-tube into a 100 cm^3 beaker, ¾ full of cold water.
- Cautiously smell the contents of the beaker.

Observation ....

....

Use your observations above to suggest the type of compound present in **FB 8**.

....

[2]

[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, $NH_4^+(aq)$	no ppt. 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. turning brown on contact with air insoluble in excess	green ppt. turning brown on contact with air 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. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air 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 → (pale) brown NO_2 in air)
sulfate, SO_4^{2-}(aq)	gives white ppt. with Ba^{2+}(aq) or with Pb^{2+}(aq) (insoluble in excess dilute strong acids)
sulfite, SO_3^{2-}(aq)	SO_2 liberated with dilute acids; gives white ppt. with Ba^{2+}(aq) (soluble in excess dilute strong acids)

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
sulfur dioxide, SO_2	turns acidified aqueous potassium dichromate(VI) from orange to green

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