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

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

6145475750

CHEMISTRY **9701/36**

Advanced Practical Skills 2 **October/November 2011**

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 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 **11** printed pages and **1** blank page.

DC (SJF) 52039/5 **R**

UNIVERSITY *of* CAMBRIDGE
International Examinations

[Turn over

1 Iodine and propanone react together at room temperature in the presence of a catalyst.

$$CH_3COCH_3(aq) + I_2(aq) \rightarrow CH_3COCH_2I(aq) + HI(aq)$$

In the following experiment you will investigate how the rate of reaction alters when the concentration of a reagent is changed. When the reaction is complete, the solution turns colourless as all the iodine has been used up. It is possible to determine the rate of the reaction by measuring how long it takes for the mixture to go colourless.

The product of the reaction, CH_3COCH_2I, is a strong irritant to the eyes. Make sure that at the end of each experiment you wash out the reaction flask with plenty of water.

FB 1 is 2.0 mol dm^{-3} aqueous propanone, CH_3COCH_3.
FB 2 is 3.0 mol dm^{-3} hydrochloric acid, HCl.
FB 3 is 0.0050 mol dm^{-3} aqueous iodine, I_2.

(a) Method

Read through the method and prepare a table for your results before starting any practical work.

Experiment 1

- Fill the burette labelled **FB 1** with the propanone solution, **FB 1**.
- Fill the second burette with distilled water.
- Run 20.0 cm^3 of **FB 1** into a 100 cm^3 beaker.
- Using a 25 cm^3 measuring cylinder, add 20 cm^3 of **FB 2** to the beaker.
- Using a second 25 cm^3 measuring cylinder, measure 10 cm^3 of **FB 3**.
- Add the measured **FB 3** to the solution in the 100 cm^3 beaker and start timing immediately.
- Stir the mixture once and place the beaker on a white tile.
- Stop timing as soon as the solution goes colourless. Record this reaction time to the **nearest second**.
- Wash out the beaker thoroughly.

Experiment 2

- Run 14.0 cm^3 of **FB 1** into the 100 cm^3 beaker.
- Run 6.0 cm^3 of distilled water into the 100 cm^3 beaker.
- Using the measuring cylinder, add 20 cm^3 of **FB 2** to the beaker.
- Using the second measuring cylinder, measure 10 cm^3 of **FB 3**.
- Add the measured **FB 3** to the solution in the 100 cm^3 beaker and start timing immediately.
- Stir the mixture once and place the beaker on a white tile.
- Stop timing as soon as the solution goes colourless and record the reaction time as before.
- Wash out the beaker thoroughly.

Experiment 3

Repeat the experiment as before using the volumes below.

- 8.0 cm^3 of **FB 1**
- 12.0 cm^3 of distilled water
- 20 cm^3 of **FB 2**
- 10 cm^3 of **FB 3**

Record all your results for experiments **1**, **2** and **3** in the space below showing the volume of propanone solution, **FB1**, the volume of distilled water and the reaction time.

[3]

(b) Carry out two experiments to investigate further how the reaction time changes with different concentrations of propanone. Remember that the combined volume of propanone solution and distilled water must always be 20.0 cm^3. Record these results in the space below.

[2]

(c) **(i)** Calculate the number of moles of iodine that were added in each experiment.

………………. mol

(ii) Calculate the initial concentration of the iodine in 50 cm^3 of the reaction mixture.

initial concentration of iodine = ………………. mol dm^{-3}

[2]

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

$$\text{'rate'} = \frac{\text{concentration of iodine from } \textbf{(c)(ii)}}{\text{reaction time}} \times 10^5$$

Use your experimental results to complete the following table to include the reaction time and the 'rate'.

volume of propanone solution, **FB1** / cm^3		

[2]

(e) On the grid opposite, plot the 'rate' against the volume of propanone solution, **FB1**. Draw a line of best fit through the points you have plotted.

I	
II	
III	
IV	
V	
VI	
VII	
VIII	

[8]

(f) **(i)** From your results what conclusion can you draw about the relationship between the rate of this reaction and the concentration of propanone?

....

....

(ii) Suggest an improvement to the experiment that would allow you to be more confident about this conclusion.

....

.... [3]

(g) Carry out **one** additional experiment to investigate how the 'rate' is altered when the concentration of **iodine** is halved. Record the volume of each solution used and the reaction time in the space below. Calculate the 'rate' using the equation in **(d)**.

'rate' = ……………… [2]

(h) From your results in **(d)** and **(g)**, what conclusion can you draw about the relationship between the rate of reaction and the concentration of iodine?

....

.... [1]

(i) In these experiments you used a burette to measure 20.0 cm^3 of **FB 1**. Calculate the percentage error in measuring this volume.

percentage error = ……………… [2]

[Total: 25]

2 Qualitative Analysis

At each stage in 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 full name or correct formula of the reagents must be given.

FB 4, **FB 5** and **FB 6** are aqueous solutions each of which contains a single cation and a single anion. One of these solutions is a dilute acid and this is the only acid present.
By carrying out specific tests you will identify all three compounds.

(a) **(i)** Select a single chemical reagent which would allow you to identify the dilute acid. You may not use indicator paper.

reagent ……………………………………….

(ii) Use this reagent to test all three solutions and record your observations in an appropriate form in the space below.

(iii) From your observations in **(ii)**, identify which solution is the dilute acid.

FB ……………………………………… is the dilute acid. [4]

(b) The acid you have identified in **(a)(iii)** is dilute sulfuric acid.

Complete the following table.

test	*observations*
To 1 cm depth of **FB 4** in a test-tube, add 1 cm depth of **FB 5.**	
To 1 cm depth of **FB 5** in a test-tube, add 1 cm depth of **FB 6.**	
To 1 cm depth of **FB 6** in a test-tube, add 1 cm depth of **FB 4.**	

[3]

(c) Test the two remaining unidentified solutions separately with aqueous sodium hydroxide and aqueous ammonia. Record your observations in a suitable form below. You are reminded that if any solution is warmed a boiling tube **MUST** be used.

[4]

(d) From your observations in **(a)**, **(b)** and **(c)**, identify the ions present in the two so tested in **(c)**, giving the relevant evidence for each. If you have not been able to ide one or more of the ions, explain why the evidence obtained was insufficient.

FB .... cation .... evidence ....

....

....

.... anion .... evidence ....

....

....

FB .... cation .... evidence ....

....

....

.... anion .... evidence ....

....

....

[4]

[Total: 15]

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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