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Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0597751623

CHEMISTRY **9701/36**

Paper 3 Advanced Practical Skills 2 **October/November 2015**

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
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	

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1 You will investigate the rate of reaction between iron(III) ions, Fe^{3+}, and iodide ions, I^-.

$$2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(aq)$$

The iodine, I_2, produced can be reacted immediately with thiosulfate ions, $S_2O_3^{2-}$.

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

When all the thiosulfate has been used, the iodine produced will turn starch indicator blue-black. The rate of the reaction can therefore be measured by finding the time for the blue-black colour to appear.

FB 1 is aqueous iron(III) chloride, $FeCl_3$.
FB 2 is aqueous potassium iodide, KI.
FB 3 is 0.0060 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$.
starch indicator

You are advised to read the instructions before starting any practical work and draw a table for your results in the space on page 3.

(a) Method

Experiment 1

- Fill a burette with **FB 1**.
- Run 20.00 cm^3 of **FB 1** into a 100 cm^3 beaker.
- Use the measuring cylinder to place the following in a second 100 cm^3 beaker.
  - 10 cm^3 of **FB 2**
  - 20 cm^3 of **FB 3**
  - 10 cm^3 of starch indicator
- Add the contents of the second beaker to the first beaker and start timing.
- Stir the mixture once and place the beaker on the white tile.
- The mixture turns brown and then yellow before turning a blue-black colour. Stop timing when this **blue-black colour** appears.
- Record in your table the volume of **FB 1** used, the volume of distilled water used and the time to the **nearest second** for the blue-black colour to appear.
- Wash both beakers.

For each of **Experiments 2-6** you should complete your results table to show the volume of **FB 1** used, the volume of distilled water used and the time taken to the **nearest second** for the blue-black colour to appear.

Experiment 2

- Fill the other burette with distilled water.
- Run 10.00 cm^3 of **FB 1** into a 100 cm^3 beaker.
- Run 10.00 cm^3 of distilled water into the same beaker.
- Use the measuring cylinder to place the following in a second 100 cm^3 beaker.
  - 10 cm^3 of **FB 2**
  - 20 cm^3 of **FB 3**
  - 10 cm^3 of starch indicator
- Add the contents of the second beaker to the first beaker and start timing.
- Stir the mixture once and place the beaker on the white tile.
- Stop timing when a blue-black colour appears.
- Wash both beakers.

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Experiments 3-6

Carry out **four** further experiments to investigate the effect of changing the concentration of $Fe^{3+}(aq)$ by altering the volume of aqueous $FeCl_3$, **FB 1**, used.

You should not use a volume of **FB 1** that is less than 6.00 cm^3 and the total volume of the reaction mixture must always be 60 cm^3.

I	
II	
III	
IV	
V	
VI	
VII	
VIII	

[8]

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(b) Calculations

The rate of reaction can be found by calculating the change in concentration of $Fe^{3+}(aq)$ that occurred when enough iodine was produced to change the colour of the indicator to blue-black.

Use your data and the equations on page 2 to carry out the following calculations.

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

(i) Calculate the number of moles of thiosulfate ions, $S_2O_3^{2-}$ used in each experiment in **(a)**.

moles $S_2O_3^{2-}$ = ... mol

(ii) Calculate the number of moles of iodine, I_2, that react with the number of moles of $S_2O_3^{2-}$ in **(i)**.

moles I_2 = ... mol

(iii) Calculate the number of moles of iron(III) ions, Fe^{3+}, that were used to produce the number of moles of iodine in **(ii)**.

moles Fe^{3+} = ... mol

(iv) When the moles of Fe^{3+} that you calculated in **(iii)** reacted, a change in the concentration of moles of Fe^{3+} occurred. Calculate this change in concentration.

change in concentration of $Fe^{3+}(aq)$ = ... $mol\,dm^{-3}$

(v) The following formula can be used as a measure of the 'rate of reaction'.

$$\text{'rate of reaction'} = \frac{\text{change in concentration of } Fe^{3+}(aq)}{\text{reaction time}} \times 10^6$$

Complete the table to show the volume of **FB 1**, the reaction time and the rate in **Experiments 1-6**. You should include units.

If you were unable to calculate a value for the change in concentration of $Fe^{3+}(aq)$ in **(iv)**, you should assume it is $2.50 \times 10^{-3}\,mol\,dm^{-3}$. (Note: this is not the correct value.)

Experiment			
1			
2			
3			
4			
5			
6			

[5]

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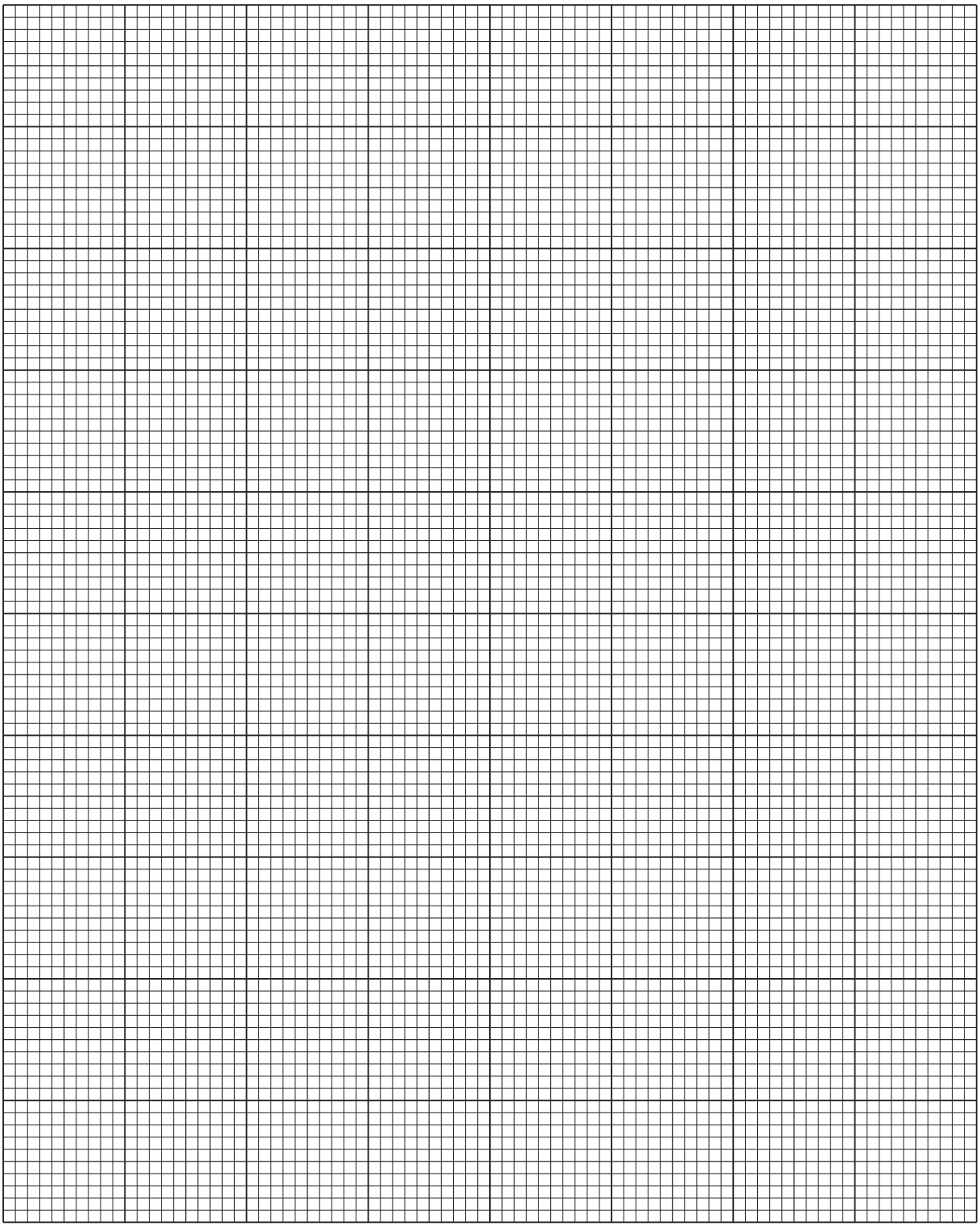
(c) On the grid, plot the rate (*y*-axis) against the volume of **FB 1** (*x*-axis). Draw a line of best fit through the points. You should identify any points you consider anomalous.



[4]

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(d) Using your graph, what conclusion can you reach about the effect of changing the concentration of $FeCl_3$ on the rate of the reaction between $Fe^{3+}(aq)$ and $I^-(aq)$?

.....

.....

..... [2]

(e) A student wanted to investigate how changing the concentration of I^- would affect the rate of reaction. Explain how this investigation could be carried out.

.....

.....

.....

..... [2]

(f) It was found, by carrying out experiments similar to those used in **(a)**, that increasing the concentration of I^- increased the rate of the reaction.

The student suggested modifications to the method as used in **(a)**. In each case, state what the effect would be on the **reaction time** in Experiment 1 and explain how these changes would affect the **possible errors** in the measurements.

Suggested modification 1
The reaction was carried out using the same volumes of all reagents but with the concentrations of **FB 1** and **FB 2** being double their original values.

.....

.....

.....

Suggested modification 2
The reaction was carried out using half the volume of all reagents.

.....

.....

.....
[4]

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(g) (i) Which of the experiments you carried out in **(a)** had the greatest percentage error in the reaction time?

.....

(ii) Calculate this percentage error. Assume that the error in measuring the reaction time is ±0.5 s.

percentage error = ... %
[2]

[Total: 27]

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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.

Half fill the 250 cm^3 beaker with water and heat it to about 80 °C and then switch off the burner. This will be used as a water bath in (b).

Keep two clean, dry test-tubes for use in (b).

(a) **FB 4** and **FB 5** each contain two cations and one anion. One of the cations in **FB 4** is the same as one of the cations in **FB 5**. The anion in **FB 4** is the same as the anion in **FB 5**.

(i) Separately dissolve about half of each of your samples of **FB 4** and **FB 5** in about 5 cm depth of distilled water in a boiling tube.

Carry out the following tests and record your observations in the table.

test	*observations*	
	FB 4	**FB 5**
To a 1 cm depth of solution in a test-tube, add a 1 cm depth of aqueous edta.		
To a 1 cm depth of solution in a test-tube, add a 1 cm depth of aqueous potassium iodide.		

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test	*observations*	
	FB 4	**FB 5**
To a 1 cm depth of solution in a test-tube, add aqueous sodium hydroxide.		
To a 1 cm depth of solution in a test-tube, add aqueous ammonia.		
To a 1 cm depth of solution in a test-tube, add a 1 cm depth of aqueous barium chloride or aqueous barium nitrate, then		
add dilute hydrochloric acid.		

(ii) From the observations identify three of the ions present in **FB 4** and **FB 5**.

The anion present in both **FB 4** and **FB 5** is ..... .

One cation present in **FB 4** is ..... .

One cation present in **FB 5** is ..... .

(iii) **FB 4** and **FB 5** each contain another cation from the list on page 11. This cation is the same in both **FB 4** and **FB 5**.

Carry out a test to identify this cation. Record details of the test and your observations.

.....

.....

.....

Identify the cation present in both **FB 4** and **FB 5**.

Cation is ..... .

[8]

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(b) **FB 6** is an aqueous solution of an organic compound.

(i) Complete the table below. The observation with 2,4-dinitrophenylhydrazine has already been made.

test	*observations*
To a 1 cm depth of **FB 6** in a test-tube, a few drops of 2,4-dinitrophenylhydrazine were added.	orange precipitate formed
To a 1 cm depth of **FB 6** in a test-tube, add a 2 cm depth of dilute sulfuric acid. Place the test-tube in the water bath. Then add two or three drops of acidified aqueous potassium manganate(VII).	
To a 1 cm depth of aqueous silver nitrate in a test-tube, add a few drops of aqueous sodium hydroxide. Then add aqueous ammonia until the brown precipitate **just** dissolves. To this, add a 1 cm depth of **FB 6**. Place the test-tube in the water bath and leave to stand. **Care: rinse the tube as soon as you have completed this test.**	

(ii) What conclusion can you make about the identity of **FB 6** from the observation of its reaction with 2,4-dinitrophenylhydrazine?

.....

(iii) What conclusion can you make about the identity of **FB 6** from the observation of its reactions with acidified potassium manganate(VII) and silver nitrate in ammonia solution?

.....

(iv) What change in the oxidation state of silver occurs in the reaction between **FB 6** and silver nitrate in ammonia solution?

change from ..... to .....

[5]

[Total: 13]

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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
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

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2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chloride, Cl^-(aq)	gives white ppt. with Ag^+(aq) (soluble in NH_3(aq))
bromide, Br^-(aq)	gives cream ppt. with Ag^+(aq) (partially soluble in NH_3(aq))
iodide, I^-(aq)	gives yellow ppt. with Ag^+(aq) (insoluble in NH_3(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) (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 manganate(VII) from purple to colourless

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