Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

7278217255

CHEMISTRY **9701/34**

Paper 3 Advanced Practical Skills 2 **October/November 2014**

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 10 and 11.

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	
3	
Total	

This document consists of **11** printed pages and **1** blank page.

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CAMBRIDGE International Examinations

[Turn over

1 Hydrogen peroxide, H_2O_2, is used in hair bleach and for skin therapies. In this experiment you will determine the concentration of a solution of hydrogen peroxide by titration with acidified potassium manganate(VII).

FB 1 is 0.0250 mol dm^{-3} potassium manganate(VII), $KMnO_4$.
FB 2 is dilute sulfuric acid, H_2SO_4.
FB 3 is aqueous hydrogen peroxide, H_2O_2.

(a) Method

Dilution of FB 3

- Pipette **25.0 cm^3** of **FB 3** into the volumetric (graduated) flask.
- Make the solution up to the mark using distilled water.
- Shake the flask thoroughly.
- This diluted solution of hydrogen peroxide is **FB 4**.

Titration

- Fill the burette with **FB 1**.
- Pipette **10.0 cm^3** of **FB 4** into a conical flask.
- Use a measuring cylinder to add 25 cm^3 of **FB 2** into the same flask.
- Add **FB 1** until a permanent pale pink colour is seen.
- Perform a **rough** titration and record your burette readings in the space below.

The rough titre is .... cm^3.

- Carry out as many accurate titrations as you think necessary to obtain consistent results.
- Make sure any recorded results show the precision of your practical work.
- Record in a suitable form below all of your burette readings and the volume of **FB 1** added in each accurate titration.

Keep solution **FB 2** for use in Question 3 and solution **FB 3** for use in Questions 2 and 3.

I	
II	
III	
IV	
V	
VI	
VII	

[7]

(b) From your accurate titration results, obtain a suitable value for the volume of **FB 1** to be used in your calculations.
Show clearly how you have obtained this value.

10.0 cm^3 of **FB 4** required .... cm^3 of **FB 1**. [1]

(c) 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 potassium manganate(VII) present in the volume calculated in **(b)**.

moles of $KMnO_4$ = ... mol

(ii) Complete the equation below for the reaction of potassium manganate(VII) with hydrogen peroxide. State symbols are not required.

.........$KMnO_4$ + $5H_2O_2$ + $3H_2SO_4$ $\rightarrow$ K_2SO_4 + $2MnSO_4$ + ...H_2O + $5O_2$

(iii) Use your answers to **(i)** and **(ii)** to calculate the number of moles of hydrogen peroxide used in each titration.

moles of H_2O_2 = ... mol

(iv) Calculate the concentration of H_2O_2 in **FB 4**, in mol dm^{-3}.

concentration of H_2O_2 in **FB 4** = ... mol dm^{-3}

(v) Calculate the concentration of H_2O_2 in **FB 3**, in mol dm^{-3}.

concentration of H_2O_2 in **FB 3** = ... mol dm^{-3}
[5]

[Total: 13]

2 In this experiment you will determine the enthalpy change, Δ*H*, for the catalytic decomposition of hydrogen peroxide into water and oxygen.

$$H_2O_2(aq) \rightarrow H_2O(l) + \tfrac{1}{2}O_2(g)$$

FB 3 is aqueous hydrogen peroxide, H_2O_2.
FB 5 is manganese(IV) oxide, MnO_2, the catalyst for the decomposition.

(a) Method

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

- For the **first** experiment, support the plastic cup inside the 250 cm^3 beaker.
- Use a measuring cylinder to transfer 40 cm^3 of distilled water into the plastic cup.
- Use a measuring cylinder to add 10 cm^3 of **FB 3** into the plastic cup.
- Measure and record the initial temperature of the mixture.
- Add a heaped spatula measure of **FB 5** to the mixture in the plastic cup.
- Stir constantly until the maximum temperature is reached and record this temperature.
- Calculate and record the temperature rise.
- Wash and wipe out your plastic cup and rinse the thermometer, ready for the second experiment.

- For the **second** experiment, support the plastic cup inside the 250 cm^3 beaker.
- Use a measuring cylinder to transfer 30 cm^3 of distilled water into the plastic cup.
- Use a measuring cylinder to add 20 cm^3 of **FB 3** into the plastic cup.
- Measure and record the initial temperature of the mixture.
- Add a heaped spatula measure of **FB 5** to the mixture in the plastic cup.
- Stir constantly until the maximum temperature is reached and record this temperature.
- Calculate and record the temperature rise.
- Wash and wipe out your plastic cup and rinse the thermometer, ready for the third experiment.

- Carry out the **third** experiment in a similar way.
- Transfer 20 cm^3 of distilled water into the plastic cup.
- Add 30 cm^3 of **FB 3** into the plastic cup.
- Measure and record the initial temperature of the mixture.
- Add a heaped spatula measure of **FB 5** to the mixture in the plastic cup.
- Record the maximum temperature, then calculate and record the temperature rise.

- For the **fourth** experiment, use 10 cm^3 of distilled water and 40 cm^3 of **FB 3**.

I	
II	
III	
IV	
V	

[5]

(b) Using the grid below, plot a graph of the temperature rise (*y*-axis) against the volume of **FB 3** (*x*-axis).
Draw the line of best fit.

I	
II	
III	
IV	

[4]

(c) Calculation

(i) Use your graph to calculate the average temperature rise for each 1.0 cm^3 of **FB 3** used. Show your working clearly on the graph.

average temperature rise = ... °C

(ii) Calculate the energy released for each 1.0 cm^3 of **FB 3** used.
(Assume that 4.2 J are needed to raise the temperature of 1.0 cm^3 of solution by 1.0 °C.)

energy released = ... J

(iii) Use your answer to **1(c)(v)** to calculate the number of moles of hydrogen peroxide in 1.0 cm^3 of **FB 3**.
(If you were unable to calculate the concentration of H_2O_2 in **FB 3**, assume that it was 1.72 mol dm^{-3}. Note: this is not the correct value.)

number of moles of H_2O_2 = ... mol

(iv) Calculate the enthalpy change, in kJ mol^{-1}, for the reaction below.

$$H_2O_2(aq) \rightarrow H_2O(l) + \frac{1}{2}O_2(g)$$

enthalpy change = ... kJ mol^{-1}
(sign) (value)

[4]

(d) Which **one** of the four experiments that you carried out is likely to be the least accurate? Explain your choice.

....

....

.... [1]

[Total: 14]

3 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.
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.

(a) You will carry out further experiments with aqueous hydrogen peroxide, **FB 3**.

FB 2 is dilute sulfuric acid, H_2SO_4.
FB 3 is aqueous hydrogen peroxide, H_2O_2.
FB 6 is a solution containing two cations and one anion.
FB 7 is a solution containing one cation and one anion.

(i) To a 1 cm depth of **FB 6** in a boiling tube, add aqueous sodium hydroxide until it is in excess. Then heat the tube, gently and with care. Keep the mixture for test **(ii)**.
Record your observations. Identify the cations in **FB 6**.

observations ....

....

....

FB 6: cations are .... and ....

(ii) To the mixture obtained from **(i)** add a 1 cm depth of **FB 3**. Shake the tube.
Record your observations.

observations ....

....

....

What **type** of reaction has taken place? Explain your answer.

....

....

(iii) To a 1 cm depth of **FB 3** in a test-tube, add an equal volume of sulfuric acid, **FB 2**.
Then add a 1 cm depth of **FB 7**, followed by a few drops of starch solution.
Record all your observations.
Draw what conclusions you can about the ions in **FB 7**. If no conclusion is possible, write 'not known'.

observations ....

....

....

FB 7: cation .... anion ....

[7]

(b) **FB 7**, **FB 8** and **FB 9** are aqueous solutions, each containing one cation and one anion. Note that **FB 7** was also used in **(a)(iii)**.

(i) Carry out the following tests in test-tubes.
Use 1 cm depths of solutions.
Complete the table by recording your observations.

test	*observations*		
	FB 7	**FB 8**	**FB 9**
add a 2 cm strip of magnesium ribbon			
FB 7			
FB 8			

(ii) Suggest the identify of the cation in **FB 9**.
Explain your answer.

cation ....

explanation ....

(iii) Give the ionic equation for the reaction between **FB 7** and **FB 9**.

....

(iv) From your observations, identify **FB 8**.

....
[6]

[Total: 13]

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

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 $\rightarrow$ (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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