Surname	Centre Number	Candidate Number
First name(s)		2

GCE A LEVEL

1410U50-1A

Z22-1410U50-1A-R1

TUESDAY, 17 MAY 2022

CHEMISTRY – A2 unit 5

Practical Examination

Experimental Task

TEST 1

3 hours

For Teacher's use only Award a mark of 0 or 1 for each of the following	
Efficient use of time	
Working safely	

For Examiner's use only	
Mark Awarded	
Total	

1410U501A
01

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator, pencil and ruler;
- **Data Booklet** supplied by WJEC.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Pencil may be used to draw tables and graphs.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The total number of marks available for this task is 30.
Your teacher will directly assess your practical skills in **Parts A** and **B**.
The number of marks is given in brackets at the end of each question or part-question.
You are reminded of the necessity for orderly presentation in your answers.

This practical examination is in two parts:

Part A – To find the enthalpy change for the thermal decomposition of potassium hydrogencarbonate

To find the enthalpy change for the thermal decomposition of potassium hydrogencarbonate indirectly you will carry out two successive enthalpy experiments – reacting potassium hydrogencarbonate and potassium carbonate with excess hydrochloric acid.

Part B – Qualitative analysis of an unknown s-block metal carbonate

A series of tests to identify the unknown s-block metal cation in the sample provided.

The apparatus and chemicals required are listed on the following pages.

You should record all observations in the spaces provided and then use the results in the analysis section later in this paper.

Part A – To find the enthalpy change for the thermal decomposition of potassium hydrogencarbonate

Apparatus

You will need eye protection and the following apparatus:

1 × weighing bottle + lid containing approximately 3.5 g of potassium hydrogencarbonate ($KHCO_3$)
1 × weighing bottle + lid containing approximately 3.0 g of potassium carbonate (K_2CO_3)
1 × 50 cm^3 burette
1 × burette stand
1 × funnel
1 × polystyrene cup
1 × 250 cm^3 beaker
1 × thermometer (± 0.1/0.2 °C)
1 × stopwatch

Ready access to a weighing balance

Chemicals

You will need:

approximately 100 cm^3 of 2 $mol\,dm^{-3}$ hydrochloric acid solution (HCl)

1410U501A 03

Part B – Qualitative analysis of an unknown s-block metal carbonate

Apparatus

You will need eye protection and the following apparatus:

1 × sample bottle containing approximately 2.5 g of unknown s-block metal carbonate
4 × test tube
1 × test tube rack
1 × rubber bung for test tube
1 × boiling tube
1 × wooden splint
1 × Bunsen burner
1 × spatula
1 × wash bottle (deionised water)
1 × 10 cm^3 measuring cylinder
4 × graduated plastic pipette

Chemicals

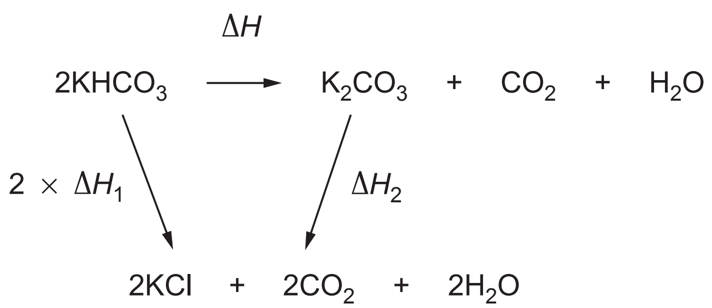
You will need:

approximately 10 cm^3 of 1 $mol\,dm^{-3}$ nitric acid solution (HNO_3)
approximately 2 cm^3 of 1 $mol\,dm^{-3}$ sodium sulfate solution (Na_2SO_4)
approximately 2 cm^3 of 1 $mol\,dm^{-3}$ sodium hydroxide solution (NaOH)

Part A – To find the enthalpy change for the thermal decomposition of potassium hydrogencarbonate

Potassium hydrogencarbonate is used as a fire suppression agent in some dry chemical fire extinguishers and in some applications of condensed aerosol fire suppression. It is the only dry chemical fire suppression agent recognized for firefighting at airport crash rescue sites. It is about twice as effective in fire suppression as sodium hydrogencarbonate. However, it can thermally decompose to potassium carbonate, therefore knowledge of the enthalpy change for this reaction is of importance with regards to storage temperatures.

To find the enthalpy change, ΔH, for the thermal decomposition of potassium hydrogencarbonate **indirectly** you will carry out two successive enthalpy experiments. You will react potassium hydrogencarbonate and then potassium carbonate with excess hydrochloric acid to determine ΔH_1 and ΔH_2 respectively. You will use these values to find ΔH using Hess's law.



You will record your data on pages 7 and 8.

Procedure

- **Wear eye protection at all times.**
- **Assume that all substances are toxic and corrosive.**

1. Accurately weigh the sample of potassium hydrogencarbonate and the weighing bottle and lid. Record the mass.
2. Stand the polystyrene cup inside the 250 cm^3 beaker for stability.
3. Use the burette to add 30 cm^3 of 2 $mol\,dm^{-3}$ hydrochloric acid solution to the polystyrene cup.
4. Record the temperature of the acid every 30 s for 2 minutes.
5. At 2½ minutes add the contents of the weighing bottle to the polystyrene cup. Stir carefully with the thermometer. Do **not** record the temperature at this point.
6. Record the temperature at 3 minutes and again every 30 s for a further 4 minutes.
7. Reweigh the weighing bottle and lid. Record the mass and hence calculate the exact mass of potassium hydrogencarbonate added to the cup. Record this value.
8. Wash and dry the polystyrene cup and repeat steps 1-7 using the potassium carbonate sample.

Use your results in the Analysis of Results section after you have completed Part B of this experimental task.

Examiner only

Results Sheet

Part A – To find the enthalpy change for the thermal decomposition of potassium hydrogencarbonate

Potassium hydrogencarbonate

Weighing data

Mass of sample of potassium hydrogencarbonate and weighing bottle and lid	g
Mass of empty weighing bottle and lid	g
Mass of potassium hydrogencarbonate added	g

Temperature data

Circle the resolution of your thermometer.

±0.1°C ±0.2°C

Draw a table to record your temperature readings.

Examiner only

Potassium carbonate

Weighing data

Mass of sample of potassium carbonate and weighing bottle and lid	g
Mass of empty weighing bottle and lid	g
Mass of potassium carbonate added	g

Temperature data

Draw a table to record your temperature readings.

Examiner only [4]

Mark awarded	

Part B – Qualitative analysis of an unknown s-block metal carbonate

You will carry out a series of tests to identify the unknown s-block metal cation in the sample provided.

Record your observations in the table on page 11.

For each of the tests, if there is no apparent change you should write ‘no observable change’.

You are **not** required to identify the metal ion present until the **Analysis of Results** section.

Procedure

- **Wear eye protection at all times.**
- **Assume that all substances are toxic and corrosive.**

Solubility

1. Place half a spatula of solid from the sample bottle in a test tube.
2. Add approximately 5 cm^3 of deionised water.
3. Place a rubber bung in the tube and shake.
4. Record your observation(s).

1410U501A 09

Add nitric acid solution

1. Place half a spatula of solid from the sample bottle in a boiling tube.
2. Add approximately 10 cm^3 of nitric acid solution.
3. Record your observation(s) and allow the boiling tube to stand for a few minutes.
4. Pour one third of the solution into one test tube and one third into another, leaving one third in the boiling tube.

Flame test

1. Place a wooden splint into the solution remaining in the boiling tube.
2. Hold the splint in a roaring blue Bunsen burner flame.
3. Record any flame colour seen.

Add sodium sulfate solution

1. Add approximately 2 cm^3 of sodium sulfate solution to one of the test tubes.

2. Record your observation(s).

Add sodium hydroxide solution

1. Add approximately 2 cm^3 of sodium hydroxide solution to the other test tube.

2. Record your observation(s).

Examiner only

Results Sheet

Part B – Qualitative analysis of an unknown s-block metal carbonate

Record your observations in the table.

Test	Observation(s)
solubility	
add nitric acid solution	
flame test	
add sodium sulfate solution	
add sodium hydroxide solution	

Use these observations in the **Analysis of Results** section.

Examiner only [4]

Mark awarded	

Analysis of Results

Part A – To find the enthalpy change for the thermal decomposition of potassium hydrogencarbonate

(i) Use the results from the reactions of potassium hydrogencarbonate and potassium carbonate with hydrochloric acid to construct two graphs on the grids provided.

From the graphs, find the maximum temperature change in both reactions.

Examiner only

Potassium hydrogencarbonate

Maximum temperature change = ... °C [3]

Turn over.

BLANK PAGE

Examiner only

Potassium carbonate

Maximum temperature change = ... °C [3]

Examiner only

(ii) Use the following equation to calculate the enthalpy change (in $kJ\,mol^{-1}$) for both reactions. [6]

$$\Delta H = -\frac{mc\Delta T}{n}$$

$$KHCO_3 + HCl \xrightarrow{\Delta H_1} KCl + CO_2 + H_2O$$

potassium hydrogencarbonate

ΔH_1 = ... $kJ\,mol^{-1}$

$$K_2CO_3 + 2HCl \xrightarrow{\Delta H_2} 2KCl + CO_2 + H_2O$$

potassium carbonate

ΔH_2 = ... $kJ\,mol^{-1}$

Examiner only

(iii) Use the answers to part (ii) to calculate the enthalpy change for the thermal decomposition of potassium hydrogencarbonate. [2]

$$2KHCO_3 \xrightarrow{\Delta H} K_2CO_3 + CO_2 + H_2O$$

ΔH = ... $kJ\,mol^{-1}$

Examiner only

Part B – Qualitative analysis of an unknown s-block metal carbonate

(iv) 2.500 g of the unknown anhydrous s-block metal carbonate was heated to constant mass and the mass of the corresponding anhydrous oxide produced was found to be 1.400 g.

Use this information and your qualitative results to confirm the identity of the unknown s-block metal in the carbonate provided.

Show your working and state the conclusions that can be drawn from **each** of the qualitative tests. [6]

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END OF PAPER

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