Surname	Centre Number	Candidate Number
First name(s)		2

GCE A LEVEL

1410U50-1A

S24-1410U50-1A

WEDNESDAY, 8 MAY 2024

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 **(Parts A & B)**	
Working safely **(Parts A & B)**	

For Examiner's use only	
Mark Awarded	
Total	

1410U501A
01

ADDITIONAL MATERIALS

- A calculator, pencil and ruler
- **Data Booklet** supplied by WJEC

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. You may use a pencil for graphs and diagrams only.
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 – Thermometric titration of sodium hydroxide solution against hydrochloric acid of unknown concentration

You will carry out a "thermometric titration" to find the concentration of a hydrochloric acid solution and use your results to calculate the enthalpy change of neutralisation for this reaction.

Part B – Qualitative analysis of unknown metal ion solutions

Using two different acids to identify solutions containing calcium, lead(II) and sodium ions.

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

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

Part A – Thermometric titration of sodium hydroxide solution against hydrochloric acid of unknown concentration

Apparatus

You will need eye protection and the following apparatus:

1 × paper cup
1 × 250 cm^3 beaker
2 × 50 cm^3 burette
2 × small funnel
2 × burette stand
1 × 100 cm^3 beaker
1 × thermometer
1 × wash bottle (deionised water)

Chemicals

You will need:

approximately 300 cm^3 of approximately 1.0 mol dm^{-3} sodium hydroxide solution, NaOH(aq) (corrosive)
approximately 200 cm^3 of hydrochloric acid solution, HCl(aq), of unknown concentration (irritant)
deionised water

You will be told the **exact concentration** of the sodium hydroxide solution by your teacher.

Record this on page 10.

Part B – Qualitative analysis of unknown metal ion solutions

Apparatus

You will need eye protection and the following apparatus:

3 × empty boiling tube
2 × boiling tube rack
2 × dropping pipette

sticky labels / marker pen

Chemicals

You will be provided with the following solutions in three labelled boiling tubes:

approximately 10 cm^3 of calcium nitrate solution, $Ca(NO_3)_2(aq)$
approximately 10 cm^3 of lead(II) nitrate solution, $Pb(NO_3)_2(aq)$
approximately 10 cm^3 of sodium nitrate solution, $NaNO_3(aq)$

These are labelled with the letters **X**, **Y** and **Z**, but you do not know which is which.

approximately 20 cm^3 of 1 mol dm^{-3} hydrochloric acid solution, HCl(aq)
approximately 20 cm^3 of 1 mol dm^{-3} sulfuric acid solution, $H_2SO_4(aq)$

Some of these solutions are classed as **irritant** or **corrosive** and lead(II) nitrate is **toxic**.
You **must** wash your hands after completing these tests.

Part A – Thermometric titration of sodium hydroxide solution against hydrochloric acid of unknown concentration

Heater meals were originally developed for military use. They are ready-made self-heating meal packs. They can be activated in many ways – by pressing a button on the packaging, by unwrapping and shaking the pack, or by pouring the contents of one bag into another and waiting for a few minutes. All of these packs use exothermic chemical reactions. To make them as efficient as possible, companies need to know the exact concentrations of the reactants used and the amount of energy released.

In this practical, you will use a thermometric titration to find the concentration of a hydrochloric acid solution and use your results to calculate the enthalpy change of neutralisation for this reaction.

Procedure

- **Wear eye protection at all times**
- **Assume that all chemicals are corrosive**

1. Place the paper cup into the 250 cm^3 beaker for stability.

2. Carefully run exactly 50.0 cm^3 of sodium hydroxide solution from one of the burettes into the paper cup. **Do not completely empty the burette.**

3. Measure the temperature of the sodium hydroxide solution to the appropriate precision and record it on page 7 in a table of your own design.

4. Carefully measure 10.0 cm^3 of hydrochloric acid solution from the other burette into a 100 cm^3 beaker.

5. Add the 10.0 cm^3 of acid to the paper cup and stir carefully with the thermometer. Record the highest temperature reached.

6. Carefully rinse out the paper cup and repeat the experiment four times using 50.0 cm^3 of sodium hydroxide solution with the following volumes of hydrochloric acid:

   20.0 cm^3
   30.0 cm^3
   40.0 cm^3
   50.0 cm^3

Use your results in the **Analysis of Results** section after you have completed **Part B** of the Experimental Task.

Examiner only

Results Sheet

Part A – Thermometric titration of sodium hydroxide solution against hydrochloric acid of unknown concentration

(Circle) the resolution of your thermometer.

±0.1°C ±0.2°C other (please specify) .....

Draw a table to record the initial and final temperature and the temperature increase for each volume of hydrochloric acid.

Ensure the table includes clear titles and units and appropriate numbers of significant figures for all data.

Examiner only

Results – recording	

[3]

Results – accuracy and trend	

[3]

Part B – Qualitative analysis of unknown metal ion solutions

A student suggested that all acid-base reactions should release the same amount of energy per mole.

Another suggested that due to variations in **solubility** this may not necessarily be the case. She suggested testing the solubilities of certain metal salts to make a prediction.

Solutions **X**, **Y** and **Z** each contain calcium ions, lead(II) ions or sodium ions. You will test each solution with hydrochloric acid and sulfuric acid to identify which solution contains which ions.

Record your observations in the table on page 9.

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 ions until the **Analysis of Results** section.

Procedure

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

1. Pour half of solution **X** into an empty boiling tube and label this tube **X**.
2. Repeat with solutions **Y** and **Z**, labelling them appropriately.
3. Use a dropping pipette to add approximately 5 cm^3 of hydrochloric acid solution to one of the samples of solution **X**.
4. Do not shake the tube but leave to settle.
5. Repeat with solutions **Y** and **Z**.
6. After 2–3 minutes record your observations.
7. Repeat steps 3–6 with the remaining samples of **X**, **Y** and **Z** using sulfuric acid instead of hydrochloric acid.
8. **Leave all tubes in their racks for safe disposal of the contents. Do not wash any solutions down the sink.**
9. Wash your hands thoroughly.

Examiner only

Results Sheet

Part B – Qualitative analysis of unknown metal ion solutions

Record your observations in the table.

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

	Solution **X**	Solution **Y**	Solution **Z**
HCl			
H_2SO_4			

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

Examiner only

Results – observations	

[3]

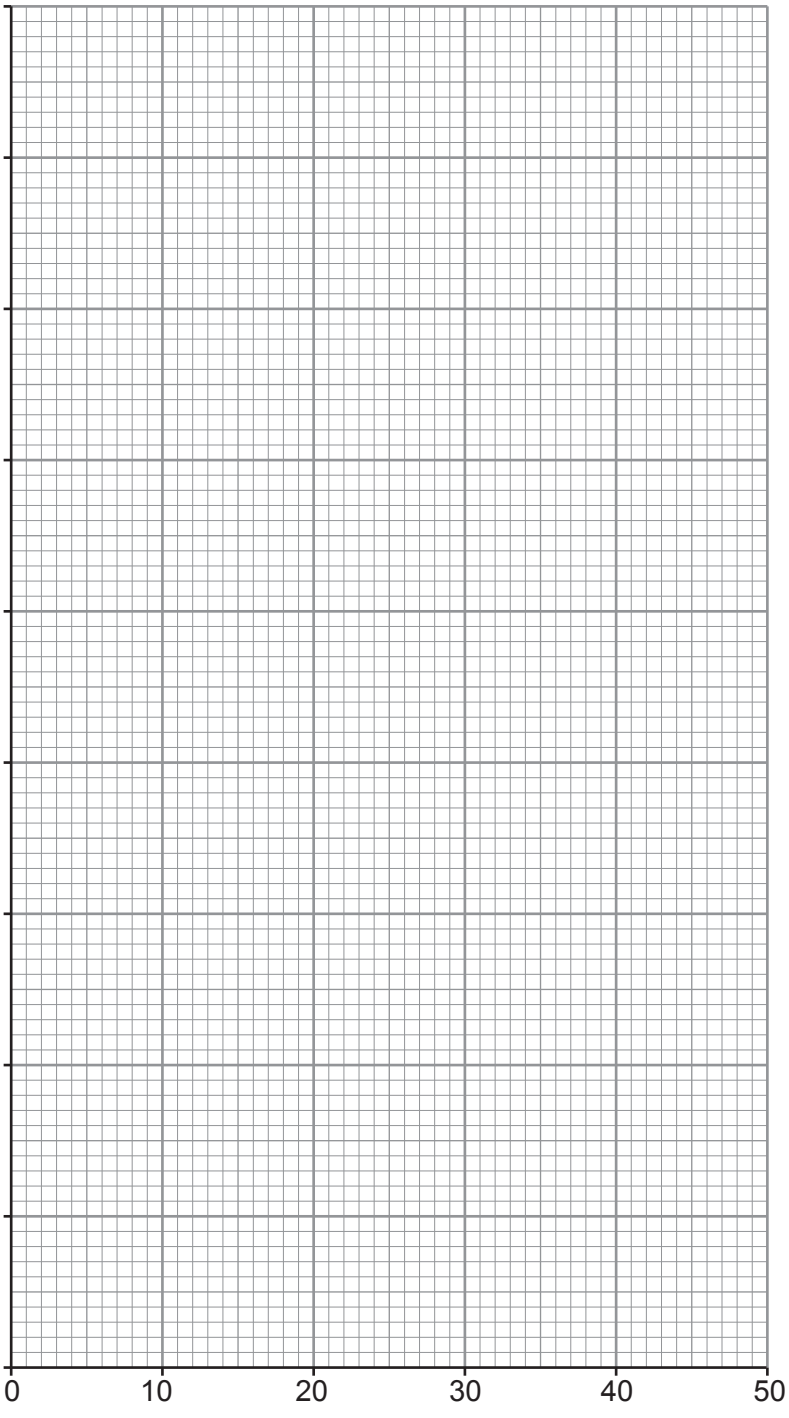
Examiner only

Analysis of Results

Part A – Thermometric titration of sodium hydroxide solution against hydrochloric acid of unknown concentration

Exact concentration of sodium hydroxide solution = ... mol dm^{-3}
(provided by your teacher)

(i) Use your results from the table on page 7. Plot the temperature increase (ΔT) against the volume of hydrochloric acid added. [4]



Examiner only

(ii) Draw a straight line through the first two points and a straight line of best fit through the last three points. Extrapolate both of these straight lines and find the volume of hydrochloric acid added at the point of intersection. [2]

Volume = ... cm^3

The point of intersection is the point where there are equimolar amounts of sodium hydroxide and hydrochloric acid.

(iii) Use the volume of hydrochloric acid at the point of intersection to calculate its concentration. [3]

Concentration = ... $mol\,dm^{-3}$

(iv) Use the temperature increase, ΔT, at the point of intersection and the equation below to calculate the enthalpy change of neutralisation, ΔH, for this reaction. [5]

$$\Delta H = -\frac{\text{total volume of solution} \times \text{specific heat capacity of water} \times \Delta T}{\text{number of moles of sodium hydroxide} \times 1000}$$

ΔH = ... $kJ\,mol^{-1}$

Examiner only

Part B – Qualitative analysis of unknown metal ion solutions

(v) Identify the metal ions present in solutions **X**, **Y** and **Z**. Give your reasoning. [3]

.....

.....

.....

.....

.....

.....

(vi) The enthalpy changes of neutralisation for sodium hydroxide, calcium hydroxide and lead(II) hydroxide with sulfuric acid have slightly different values.

Suggest which of them has the largest enthalpy change of neutralisation. Give your reasoning. [2]

.....

.....

.....

.....

END OF PAPER