



GCE A LEVEL

1410U50–1A

WEDNESDAY, 8 MAY 2024

**CHEMISTRY – A2 UNIT 5
PRACTICAL EXAMINATION**

**EXPERIMENTAL TASK
TEST 1**

**3 hours plus your additional time
allowance**

Surname: _____

First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

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	

(Turn over)

ADDITIONAL MATERIALS

- A calculator and ruler
- DATA BOOKLET supplied by WJEC.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Diagram Booklet.

The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball – point pen, black felt tip or your usual method.

Write your name, centre number and candidate number in the spaces on the front cover.

Write your answers in the spaces provided.

(Turn over)

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.

(Turn over)

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.

(Turn over)

**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 cm³ beaker**
- 2 × 50 cm³ burette**
- 2 × small funnel**
- 2 × burette stand**
- 1 × 100 cm³ beaker**
- 1 × thermometer**
- 1 × wash bottle (deionised water)**

continued on the next page . . .

(Turn over)

PART A continued**CHEMICALS**

You will need:

**approximately 300 cm³ of approximately
1.0 mol dm⁻³ sodium hydroxide solution,
NaOH(aq) (corrosive)**

**approximately 200 cm³ 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 22.

(Turn over)

**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

continued on the next page . . .

(Turn over)

PART B continued**CHEMICALS**

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

**approximately 10 cm³ of calcium nitrate solution,
Ca(NO₃)₂ (aq)**

**approximately 10 cm³ of lead(II) nitrate solution,
Pb(NO₃)₂ (aq)**

**approximately 10 cm³ of sodium nitrate solution,
NaNO₃ (aq)**

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

approximately 20 cm³ of 1 mol dm⁻³ hydrochloric acid solution, HCl(aq)

approximately 20 cm³ of 1 mol dm⁻³ sulfuric acid solution, H₂SO₄(aq)

continued on the next page . . .

(Turn over)

PART B continued

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.

continued on the next page . . .

PART A continued

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**

STEP 1. Place the paper cup into the **250 cm³** beaker for stability.

STEP 2. Carefully run exactly **50.0 cm³** of sodium hydroxide solution from one of the burettes into the paper cup. **DO NOT COMPLETELY EMPTY THE BURETTE.**

continued on the next page . . .

(Turn over)

PART A continued

STEP 3. Measure the temperature of the sodium hydroxide solution to the appropriate precision and record it in a table of your own design. A blank sheet is provided in the separate Diagram Booklet.

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

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

continued on the next page . . .

(Turn over)

PART A continued

STEP 6. Carefully rinse out the paper cup and repeat the experiment four times using **50.0 cm³** of sodium hydroxide solution with the following volumes of hydrochloric acid:

20.0 cm³

30.0 cm³

40.0 cm³

50.0 cm³

Use your results in the ANALYSIS OF RESULTS section after you have completed PART B of the Experimental Task.

continued on the next page . . .

(Turn over)

PART A continued**RESULTS SHEET FOR PART A – THERMOMETRIC
TITRATION OF SODIUM HYDROXIDE SOLUTION
AGAINST HYDROCHLORIC ACID OF UNKNOWN
CONCENTRATION**

Identify the resolution of your thermometer.

$\pm 0.1^{\circ}\text{C}$

$\pm 0.2^{\circ}\text{C}$

other (please specify)_____

continued on the next page . . .

(Turn over)

PART A continued

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.

There is a blank page provided for this table in the separate Diagram Booklet.

PART A continued**EXAMINER ONLY**

RESULTS – RECORDING	
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[3 marks]

RESULTS – ACCURACY AND TREND	
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[3 marks]**(Turn over)**

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 provided in the separate Diagram Booklet.

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

continued on the next page . . .

(Turn over)

PART B continued

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**

STEP 1. Pour half of solution **X** into an empty boiling tube and label this tube **X**.

STEP 2. Repeat with solutions **Y** and **Z**, labelling them appropriately.

STEP 3. Use a dropping pipette to add approximately **5 cm³** of hydrochloric acid solution to one of the samples of solution **X**.

continued on the next page . . .

(Turn over)

PART B continued

STEP 4. Do not shake the tube but leave to settle.

STEP 5. Repeat with solutions **Y** and **Z**.

STEP 6. After **2 – 3** minutes record your observations.

STEP 7. Repeat steps **3 – 6** with the remaining samples of **X**, **Y** and **Z** using sulfuric acid instead of hydrochloric acid.

STEP 8. **LEAVE ALL TUBES IN THEIR RACKS FOR SAFE DISPOSAL OF THE CONTENTS.**
DO NOT WASH ANY SOLUTIONS DOWN THE SINK.

STEP 9. Wash your hands thoroughly.

continued on the next page . . .

(Turn over)

PART B continued**RESULTS SHEET****Part B – QUALITATIVE ANALYSIS OF UNKNOWN
METAL ION SOLUTIONS**

Record your observations in the table provided in the separate Diagram Booklet.

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

Use these observations in the ANALYSIS OF RESULTS section.

EXAMINER ONLY

RESULTS – OBSERVATIONS	
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[3 marks]

(Turn over)

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 in the separate Diagram Booklet.

On the grid provided for part (i) in the separate Diagram Booklet, plot the temperature increase (ΔT) against the volume of hydrochloric acid added.

continued on the next page . . .

(Turn over)

ANALYSIS OF RESULTS for PART A continued

- (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.

Volume = _____ **cm³**
[2 marks]

continued on the next page . . .

(Turn over)

ANALYSIS OF RESULTS for PART A continued

**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.**

Space for working:

Concentration = _____ mol dm⁻³
[3 marks]

continued on the next page . . .

(Turn over)

ANALYSIS OF RESULTS for PART A continued

- (iv) Use the temperature increase, ΔT , at the point of intersection and the equation provided in the separate Diagram Booklet, to calculate the enthalpy change of neutralisation, ΔH , for this reaction.

Space for working:

$\Delta H =$ _____ kJ mol^{-1}

[5 marks]

(Turn over)

**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 marks]

continued on the next page . . .

(Turn over)

ANALYSIS OF RESULTS for PART B continued

- (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 marks]

END OF PAPER

TOTAL 30 MARKS

(Turn over)

[illegible]

(Turn over)

[illegible]



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PRACTICAL EXAMINATION

EXPERIMENTAL TASK

TEST 1

**The Diagram Booklet MUST be handed in
to the invigilators and sent for marking.**

Diagram Booklet

Surname: _____

First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

Part A – STEP 3

Blank space for Table

Part A – STEP 3

Spare blank space for Table

Results Sheet – Part B

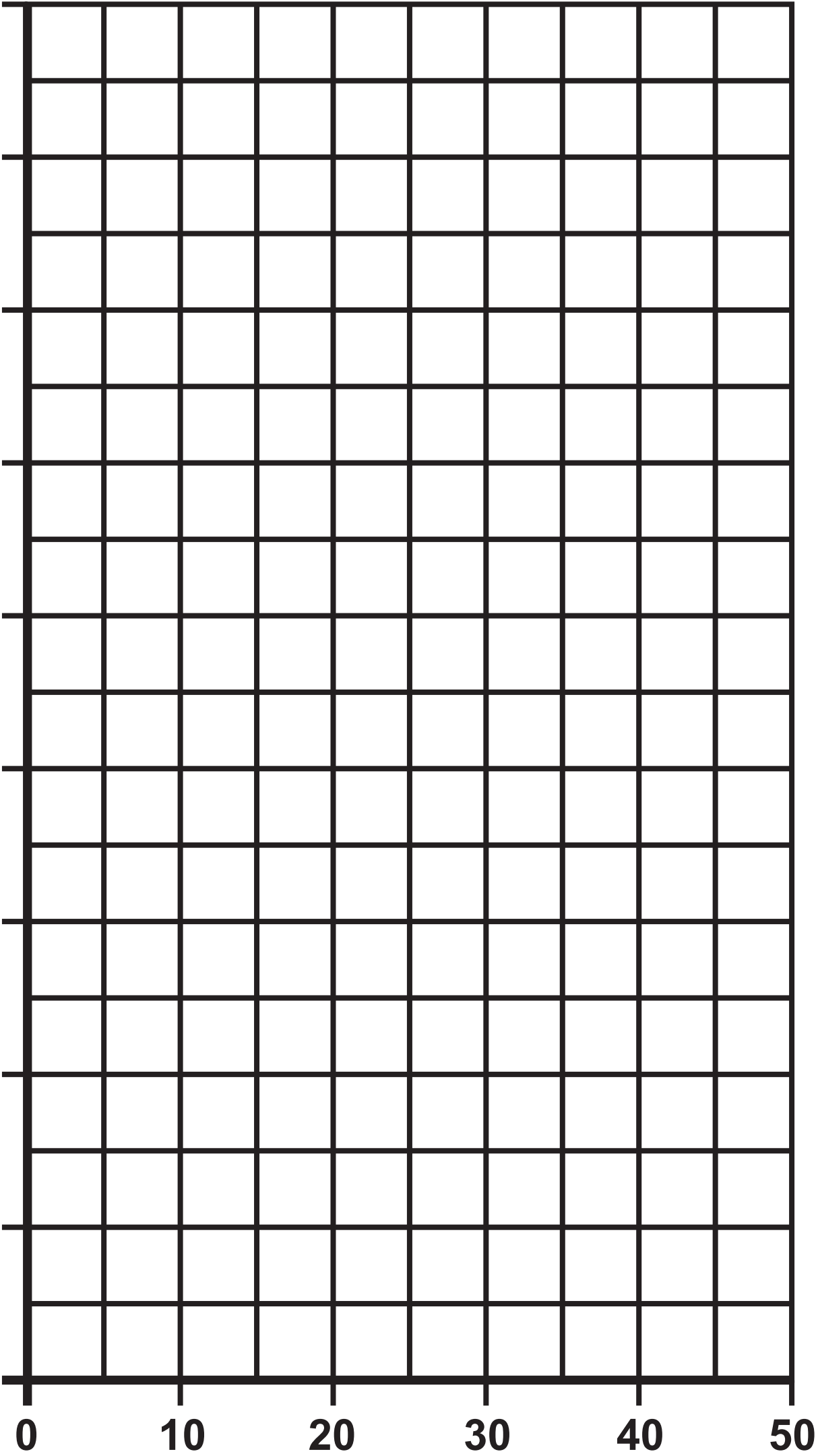
	Solution X	Solution Y	Solution Z
HCl			
H ₂ SO ₄			

Spare copy

Results Sheet – Part B

	Solution X	Solution Y	Solution Z
HCl			
H₂SO₄			

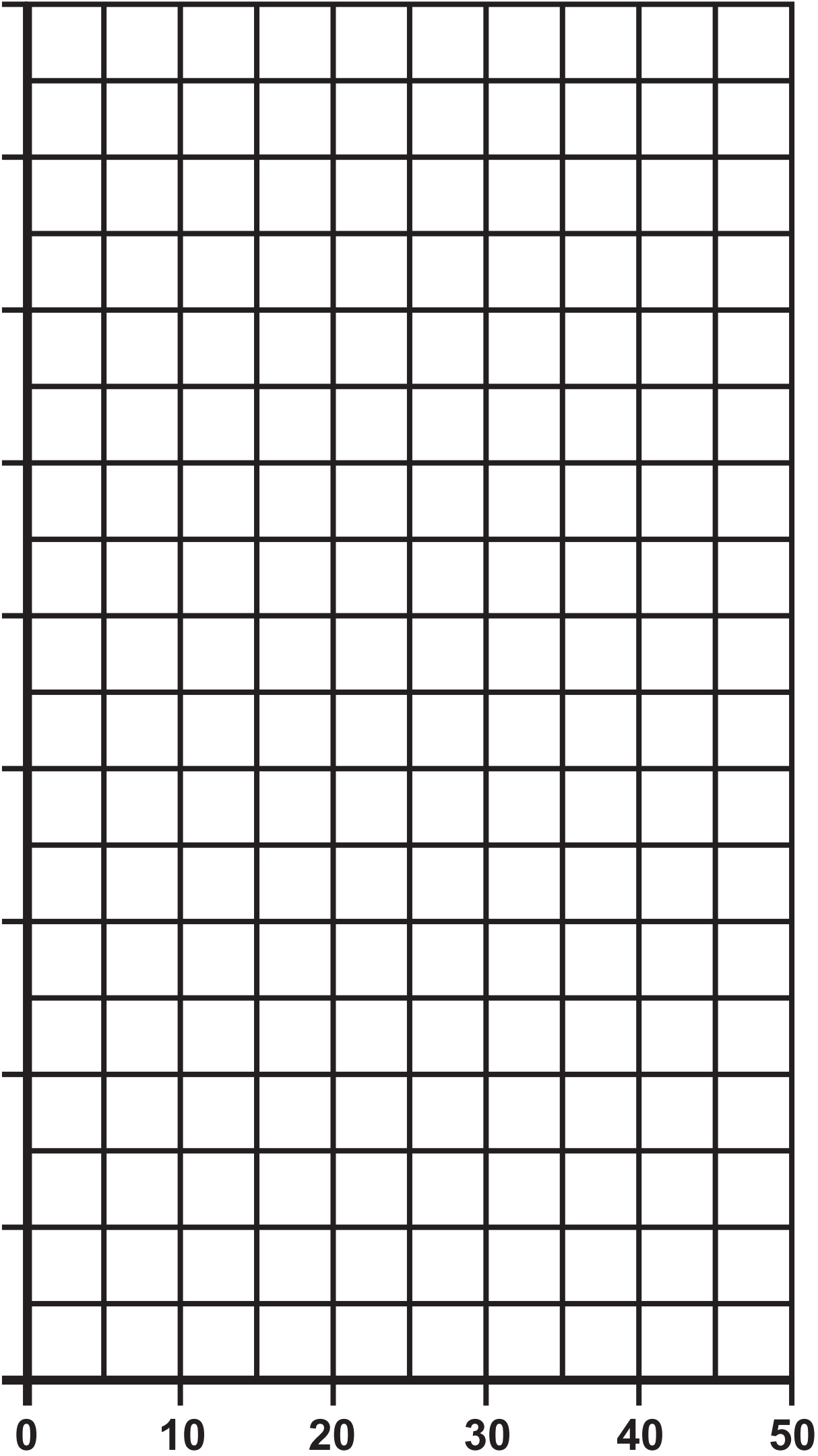
Anaylis of Results – Part (i)



Volume of hydrochloric acid / cm³

Spare copy

Anaylis of Results – Part (i)



Volume of hydrochloric acid / cm³

Analysis of Results – Part (iv)

Equation

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