



GCE AS/A LEVEL

2410U10–1

TUESDAY, 13 MAY 2025 – MORNING

CHEMISTRY – AS UNIT 1

**THE LANGUAGE OF CHEMISTRY, STRUCTURE OF
MATTER AND SIMPLE REACTIONS**

**1 hour 30 minutes plus your additional time
allowance**

Surname: _____

First name(s): _____

Centre Number: _____

Candidate Number: **2** _____

Section A

Section B

FOR EXAMINER'S USE ONLY		
Question	Maximum Mark	Mark Awarded
1. to 8.	10	
9.	15	
10.	13	
11.	14	
12.	15	
13.	13	
Total	80	

ADDITIONAL MATERIALS

- A calculator and a 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.

SECTION A Answer ALL questions.

SECTION B Answer ALL questions.

Write your answers in the spaces provided. If you run out of space, use the additional pages at the back of the booklet, taking care to number the question(s) correctly.

(Turn over)

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part – question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

The assessment of the quality of extended response (QER) will take place in Question 13 (a).

SECTION A

Answer ALL questions.

1. Using outer electrons only, draw a dot and cross diagram to show the bonding in a diatomic molecule of oxygen.

[1 mark]

2. State why the coordination number of Na^+ in NaCl is different to that of Cs^+ in CsCl .

[1 mark]

(Turn over)

3. The visible emission spectrum of hydrogen shows prominent lines at wavelengths of 434 nm, 486 nm and 656 nm.

Complete the sentences by using the words HIGHER or LOWER.

The frequency of the line at 656 nm is _____ than the frequency of the line at 434 nm.

The line at 656 nm is caused by an electronic transition of _____ energy than the line at 486 nm.

[1 mark]

4. The first four ionisation energies for an element, X, are shown in the table below.

Ionisation energy / kJ mol ⁻¹			
1st	2nd	3rd	4th
402	2650	3850	5110

Give the formula for the chloride of X.

[1 mark]

(Turn over)

5. State the total number of orbitals that are occupied in a nitrogen atom.

[1 mark]

6. Consider the following s – block elements.

Na	Mg
K	Ca
Rb	Sr
Cs	Ba

- (a) State which element forms the sulfate that is least soluble in water.

[1 mark]

- (b) State which element forms compounds which give an apple – green flame test.

[1 mark]

(Turn over)

7. The hydrogencarbonate anion has the formula HCO_3^-

Write the formula of magnesium hydrogencarbonate.

[1 mark]

8. Calculate the number of nitrogen atoms in 66.0 g of N_2O

Number of nitrogen atoms = _____

[2 marks]

(Total for SECTION A is 10 marks)

(Turn over)

SECTION B

Answer ALL questions.

- 9. (a) (i) Refer to the diagram for Question 9 (a) (i) in the separate Diagram Booklet.**

A mass spectrometer can be used to find the relative atomic mass of an element.

The diagram shows a typical mass spectrometer.

- I. Label parts **A** and **B** on the diagram.**

[2 marks]

- II. Explain why a vacuum is needed inside the mass spectrometer.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 9 (a) continued

9. (a) (ii) A sample of lead consisted of three isotopes:
 ^{206}Pb , ^{207}Pb and ^{208}Pb .

The percentage abundance of ^{207}Pb was
 22.0% and that of ^{208}Pb was 54.0%

On the grid provided for Question 9 (a) (ii) in
the separate Diagram Booklet, label the
axes and draw lines to show the mass
spectrum that this sample of lead would be
expected to give.

[3 marks]

continued on the next page . . .

(Turn over)

Question 9 continued

9. (b) Radioactive radium, ^{226}Ra , decays to the gas radon, ^{222}Rn , and eventually forms the stable lead isotope, ^{208}Pb .
- (i) ^{222}Rn is a natural radioactive gas that comes from rocks and soils. It decays by alpha emission and has a half-life of 3.8 days. Scientists are concerned about the build-up of ^{222}Rn in homes since it may cause lung cancer.
1. Explain why ^{222}Rn may cause lung cancer.

[2 marks]

continued on the next page . . .

(Turn over)

Question 9 (b) (i) continued

9. (b) (i) II. Calculate how long it would take
for 0.8 g of ^{222}Rn to decay to 0.1 g.

Time taken = _____ days
[1 mark]

- (ii) Part of the radioactive decay series of ^{226}Ra
is shown in the separate Diagram Booklet for
Question 9 (b) (ii).

Complete the series by LABELLING THE
LAST THREE ARROWS to indicate the
nature of the radioactive decay occurring in
each step.

[2 marks]

(Turn over)

Question 9 continued

9. (c) In her PhD research, Marie Curie measured the atomic mass of the element radium, which she discovered. She knew that radium is in the same family as barium, so the formula for radium chloride is RaCl_2

When 0.8779 g of pure RaCl_2 is dissolved and treated with excess AgNO_3 , 0.8490 g of AgCl is precipitated.

Calculate the relative atomic mass of radium.

Give your answer to **FOUR** significant figures.
You **MUST** show your working.

Space for working continues on the next page.

Question 9 (c) continued

$$A_r = \underline{\hspace{10cm}}$$

[4 marks]**(Total for Question 9 is 15 marks)**

(Turn over)

10. Some students wanted to determine the number of moles of water of crystallisation, X , in hydrated strontium chloride, $\text{SrCl}_2 \cdot x\text{H}_2\text{O}$

They were given the following method.

- Weigh a sample of the hydrated strontium chloride crystals in a crucible
- Heat the crucible containing the sample strongly for about 3 minutes
- Allow the crucible to cool and then reweigh

(a) One student's results are shown in TABLE 1 in the separate Diagram Booklet.

(i) COMPLETE THE TABLE.

[1 mark]

continued on the next page . . .

(Turn over)

Question 10 (a) continued

- 10. (a) (ii) Calculate the value of X to the nearest whole number. You MUST show your working.**

$X =$ _____

[3 marks]

continued on the next page . . .

(Turn over)

Question 10 (a) continued

10. (a) (iii) Each mass reading in the table has a maximum error of ± 0.005 g.

Calculate the percentage error in the mass of hydrated strontium chloride used.

Percentage error = _____ %
[1 mark]

continued on the next page . . .

(Turn over)

Question 10 continued

- 10. (b) (i) Another student heated the crystals using the yellow flame of the Bunsen burner instead of the blue flame.**

Predict the effect, if any, of this mistake on the calculated value of X .

Give your reasoning.

[2 marks]

continued on the next page . . .

(Turn over)

Question 10 (b) continued

- 10. (b) (ii) A third student found that a few crystals spat out of the crucible during heating.**

Predict the effect, if any, of this problem on the calculated value of X .

Give your reasoning.

[2 marks]

continued on the next page . . .

(Turn over)

Question 10 continued

- 10. (c) Suggest TWO improvements to the method that would help to achieve a more accurate result for the value of X . Explain your answers.**

First suggestion

Second suggestion

[4 marks]

(Total for Question 10 is 13 marks)

(Turn over)

11. (a) The boiling temperatures of some hydrides of Group 5 elements are shown below.

Hydride	Boiling temperature / °C
NH_3	–33
PH_3	–88
AsH_3	–63

- (i) Explain why the boiling temperature of PH_3 is lower than that of NH_3

[2 marks]

continued on the next page . . .

(Turn over)

Question 11 (a) continued

11. (a) (ii) Explain why the boiling temperature of PH_3 is lower than that of AsH_3

[2 marks]

continued on the next page . . .

(Turn over)

Question 11 continued

11. (b) Use the **VSEPR** theory to predict the shape of **PH₃**

Explain your answer and suggest a bond angle for the **H—P—H** bonds.

[4 marks]

continued on the next page . . .

(Turn over)

Question 11 continued

11. (c) A student is given two solutions. Both solutions contain at least one of the anions chloride, bromide and iodide.

(i) To the first solution she adds aqueous silver nitrate and a yellow precipitate is formed.

She says this means that the only halide in the solution is iodide.

Is she correct? Justify your answer.

[2 marks]

continued on the next page . . .

(Turn over)

Question 11 (c) continued

11. (c) (ii) She adds the second solution to bromine water and no obvious colour change is observed.

She says this means that the solution only contains bromide ions.

Do you agree? Justify your answer.

[2 marks]

continued on the next page . . .

(Turn over)

Question 11 continued

11. (d) Chlorine can react with water to produce hydrogen chloride and oxygen.



Explain why this reaction is classified as a redox reaction.

[2 marks]

(Total for Question 11 is 14 marks)

(Turn over)

12. (a) When lithium and hydrogen are heated together, lithium hydride is formed as colourless crystals. Lithium hydride conducts electricity when molten but not when solid.

State the type of structure present in lithium hydride. Explain why your chosen structure type has this property.

[2 marks]

- (b) Lithium hydride, LiH , reacts with aluminium chloride, AlCl_3 , to form lithium aluminium hydride, LiAlH_4 , and lithium chloride.

Write the equation for this reaction.

[1 mark]

continued on the next page . . .

(Turn over)

Question 12 continued

- 12. (c) When 1.9 g of lithium aluminium hydride is heated to 150 °C, it decomposes to give 0.90 g of aluminium, 1.22 dm³ of hydrogen (measured at 25 °C and 1 atm) and one other product.**
- (i) Calculate the molar ratio of the three named substances.**

[3 marks]

continued on the next page . . .

(Turn over)

Question 12 (c) continued

12. (c) (ii) One other product is formed.

Determine the formula of this product by writing an equation for the decomposition reaction.

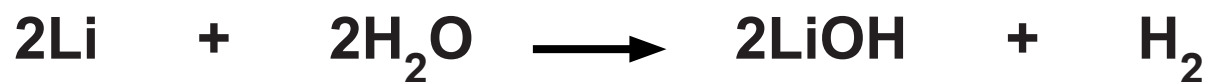
[1 mark]

continued on the next page . . .

(Turn over)

Question 12 continued

12. (d) 0.300 g of lithium reacts with an excess of water at 15 °C and 1 atm pressure to form lithium hydroxide and hydrogen.



Calculate the volume of hydrogen formed in cm^3 .

Volume of hydrogen = _____ cm^3
[4 marks]

continued on the next page . . .

(Turn over)

Question 12 continued

12. (e) Hydrogen is produced industrially by the steam reforming of methane.



- (i) Write an expression for the equilibrium constant, K_c , and give its unit, if any.

$$K_c =$$

Unit _____

[2 marks]

continued on the next page . . .

(Turn over)

Question 12 (e) continued

12. (e) (ii) The equilibrium constant, K_c , has a numerical value of 0.092 at a temperature of 1200 °C.

If the equilibrium concentration of water is 0.77 mol dm⁻³, hydrogen is 0.55 mol dm⁻³ and carbon monoxide is 0.26 mol dm⁻³, calculate the equilibrium concentration of methane at this temperature.

Concentration of methane

= _____ mol dm⁻³

[2 marks]

(Total for Question 12 is 15 marks)

(Turn over)

13. (a) A student is given a white powder and told to prove that the powder is pure calcium carbonate by finding its relative formula mass.

The relative formula mass can be found by performing a back titration.

A known mass of the powder is reacted with an excess of hydrochloric acid and the amount of unreacted acid is found by titrating against a solution of sodium hydroxide using a suitable indicator.

The equations for these reactions are in the separate Diagram Booklet for Question 13 (a).

The student is provided with 0.500 g of the powder, 25.0 cm³ of 0.500 mol dm⁻³ hydrochloric acid in a conical flask and a standardised solution of 0.200 mol dm⁻³ sodium hydroxide.

(continued on the next page)

(Turn over)

Question 13 (a) continued

Describe how he would carry out the experiment and how he would use his results to calculate the relative formula mass of calcium carbonate.

You may assume that all apparatus used is clean and that only one titration is required.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(Turn over)

continued on the next page . . .

(Turn over)

Question 13 continued

- 13. (b) Hydrochloric acid is a strong acid while ethanoic acid is a weak acid.**

The properties of a 1.00 mol dm^{-3} solution of hydrochloric acid are as follows.

- Gaseous carbon dioxide is evolved on reaction with sodium carbonate**
- It turns pH paper red**
- 25.0 cm^3 of this acid solution neutralises 25.0 cm^3 of 1.00 mol dm^{-3} sodium hydroxide solution**

- (i) State what is meant by a strong acid.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 13 (b) continued

- 13. (b) (ii) The first property listed on the previous page also applies to a 1.00 mol dm^{-3} solution of ethanoic acid.**

State whether the second and third properties apply to a 1.00 mol dm^{-3} solution of ethanoic acid. Explain your answers.

[2 marks]

continued on the next page . . .

(Turn over)

Question 13 continued

13. (c) A sample of hydrochloric acid has a concentration of 2.00 mol dm^{-3} and a volume of 100 cm^3 .

Calculate the volume of water that should be **ADDED** to this acid to dilute the sample to a concentration of 1.60 mol dm^{-3} .

Volume of water added = _____ cm^3
[2 marks]

continued on the next page . . .

(Turn over)

Question 13 continued

13. (d) Stagnant water has a potential for microbial growth. The bacteria legionella thrives in stagnant water that has a pH range of 5.5 – 8.1

Calculate the MINIMUM hydrogen ion concentration in which legionella can thrive.

$[H^+] =$ _____ mol dm^{-3}
[2 marks]

(Total for Question 13 is 13 marks)

END OF PAPER

TOTAL 80 MARKS

(Turn over)

[illegible]

(Turn over)

[illegible]

(Turn over)

[illegible]



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TUESDAY, 13 MAY 2025 – MORNING

CHEMISTRY – AS UNIT 1

**THE LANGUAGE OF CHEMISTRY, STRUCTURE OF
MATTER AND SIMPLE REACTIONS**

Diagram Booklet

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

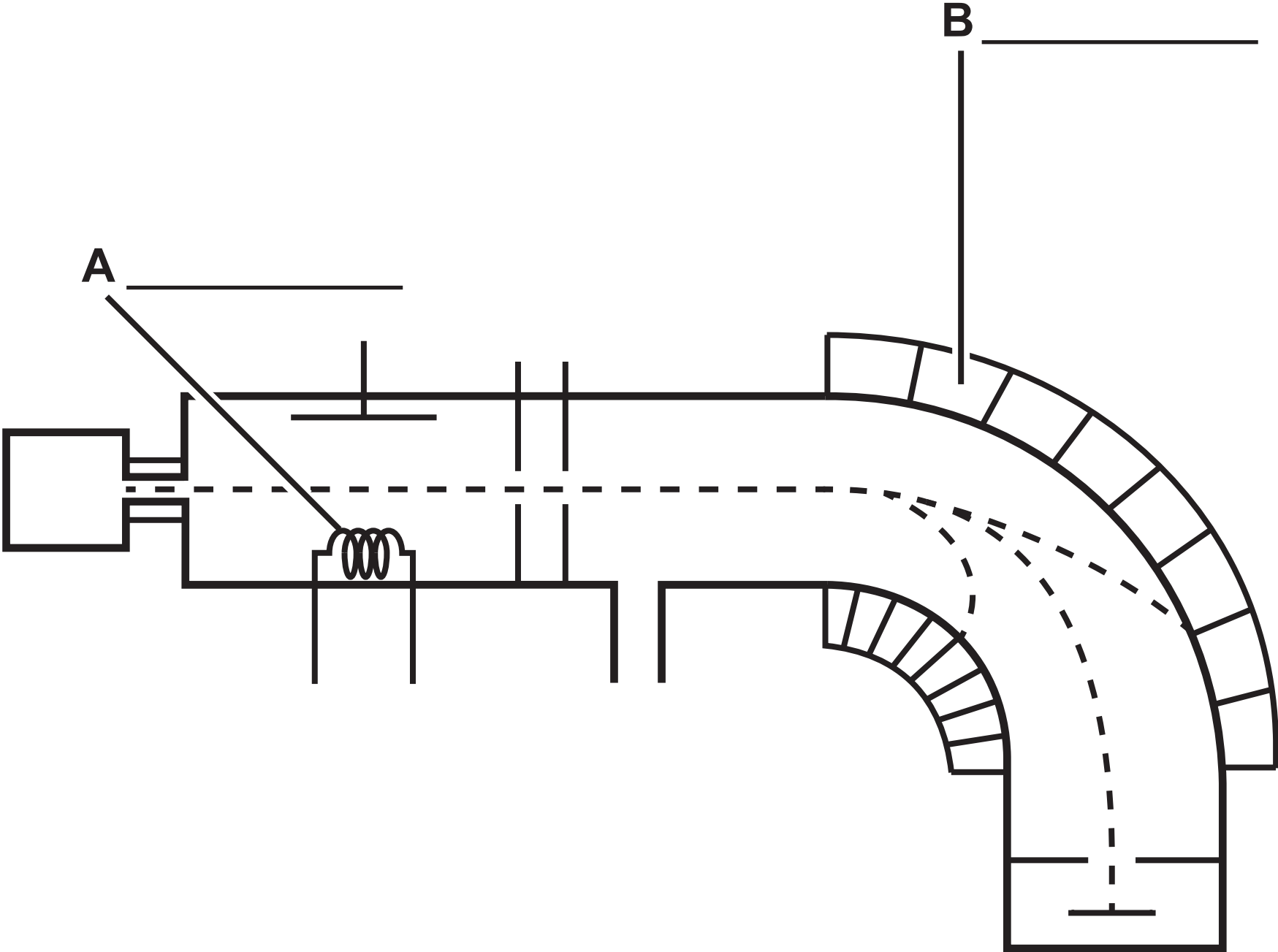
Surname: _____

First name(s): _____

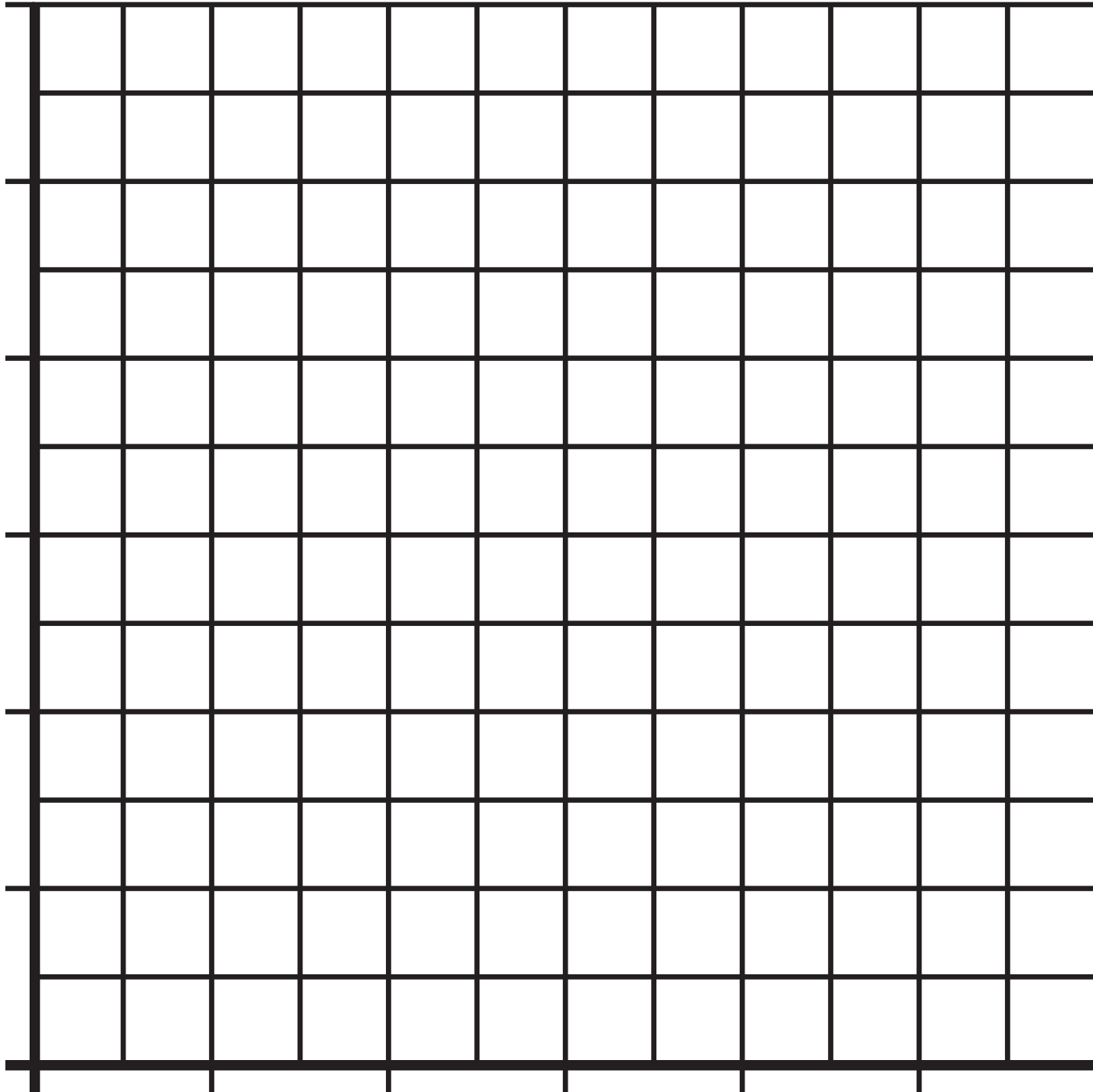
Centre Number: _____

Candidate Number: 2 _____

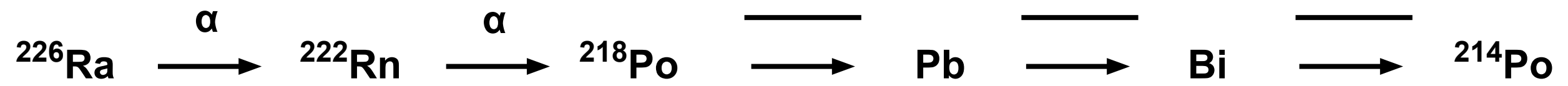
Question 9 (a) (i)



Question 9 (a) (ii)



Question 9 (b) (ii)



Question 10 (a)

TABLE 1

Weighing	Mass / g
crucible	12•12
crucible + $\text{SrCl}_2 \cdot x\text{H}_2\text{O}$ before heating	13•71
crucible + SrCl_2 after heating	13•09
$\text{SrCl}_2 \cdot x\text{H}_2\text{O}$ before heating	1•59
SrCl_2 after heating	
H_2O removed	

Question 13 (a)

