Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS/A LEVEL

S25-2410U10-1

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

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1. to 8.**	**10**	
Section B	**9.**	**15**	
	10.	**13**	
	11.	**14**	
	12.	**15**	
	13.	**13**	
	Total	**80**	

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ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

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.

Section A Answer **all** questions.
Section B Answer **all** questions.

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

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 **Q13**(a).

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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]

2. State why the coordination number of Na^+ in NaCl is different to that of Cs^+ in CsCl. [1]

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.....

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**. [1]

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.

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]

.....

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5. State the total number of orbitals that are occupied in a nitrogen atom. [1]

.....

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]

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(b) State which element forms compounds which give an apple-green flame test. [1]

.....

7. The hydrogencarbonate anion has the formula HCO_3^-.

Write the formula of magnesium hydrogencarbonate. [1]

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8. Calculate the number of nitrogen atoms in 66.0 g of N_2O. [2]

Number of nitrogen atoms = ...

10

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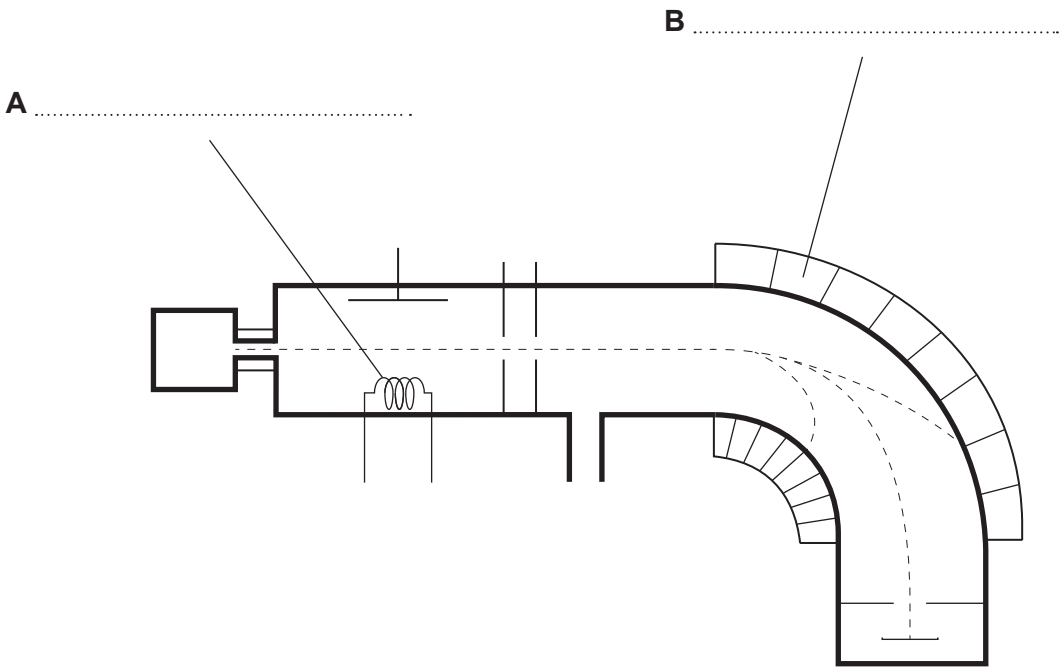
SECTION B

Answer **all** questions.

9. (a) (i) A mass spectrometer can be used to find the relative atomic mass of an element. The following diagram shows a typical mass spectrometer.



I. Label parts **A** and **B**. [2]

II. Explain why a vacuum is needed inside the mass spectrometer. [1]

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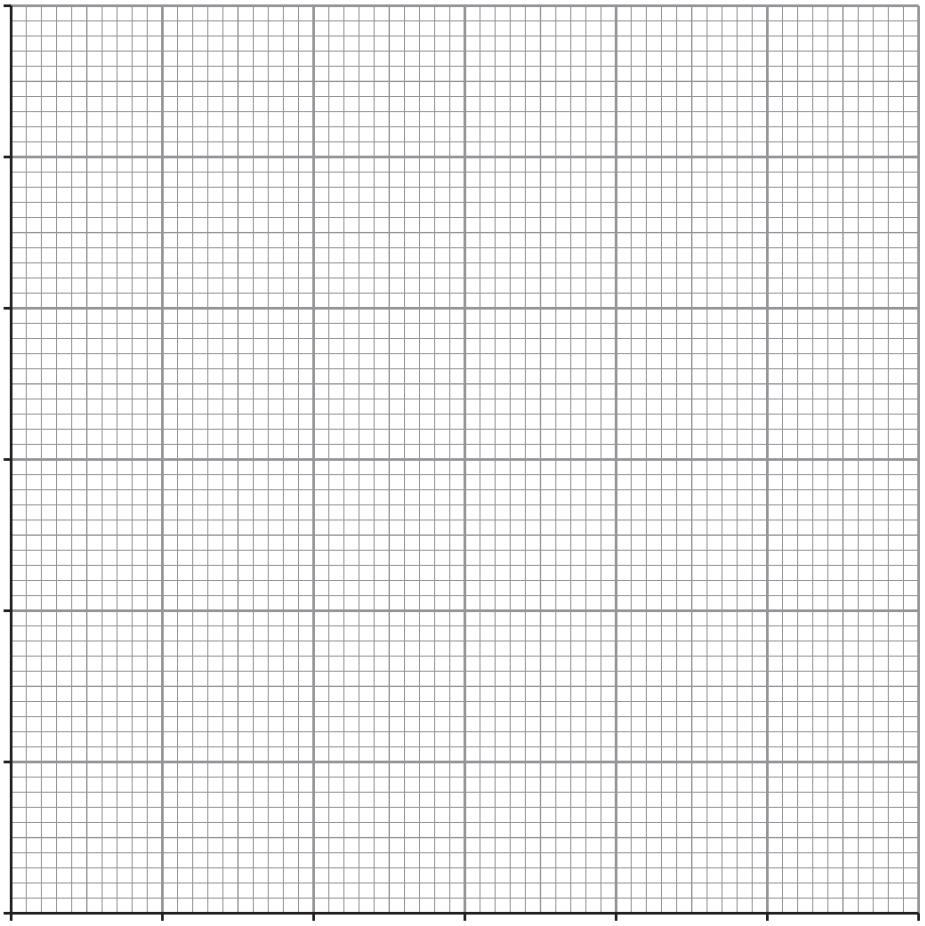
Examiner only

(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 below, label the axes and draw lines to show the mass spectrum that this sample of lead would be expected to give. [3]



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(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.

I. Explain why ^{222}Rn may cause lung cancer. [2]

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II. Calculate how long it would take for 0.8 g of ^{222}Rn to decay to 0.1 g. [1]

Time taken = ... days

(ii) Part of the radioactive decay series of ^{226}Ra is shown below.

$$^{226}Ra \xrightarrow{\alpha} {}^{222}Rn \xrightarrow{\alpha} {}^{218}Po \xrightarrow{\cdots\cdots} Pb \xrightarrow{\cdots\cdots} Bi \xrightarrow{\cdots\cdots} {}^{214}Po$$

Complete the series by **labelling the last three arrows** to indicate the nature of the radioactive decay occurring in each step. [2]

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(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. [4]

A_r = ...

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10. Some students wanted to determine the number of moles of water of crystallisation, x, in hydrated strontium chloride, $SrCl_2.xH_2O$.

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 the table below.

Weighing	Mass / g
crucible	12.12
crucible + $SrCl_2.xH_2O$ before heating	13.71
crucible + $SrCl_2$ after heating	13.09
$SrCl_2.xH_2O$ before heating	1.59
$SrCl_2$ after heating	.....
H_2O removed	.....

(i) **Complete the table.** [1]

(ii) Calculate the value of x to the nearest whole number. You **must** show your working. [3]

x = ...

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(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. [1]

Percentage error = ... %

(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]

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(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]

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(c) Suggest **two** improvements to the method that would help to achieve a more accurate result for the value of x. Explain your answers. [4]

First suggestion .....

.....

.....

Second suggestion .....

.....

.....

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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]

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(ii) Explain why the boiling temperature of PH_3 is lower than that of AsH_3. [2]

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(b) Use the VSEPR theory to predict the shape of PH_3. Explain your answer and suggest a bond angle for the H—P—H bonds. [4]

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(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]

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(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]

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

$$2Cl_2 + 2H_2O \longrightarrow 4HCl + O_2$$

Explain why this reaction is classified as a redox reaction. [2]

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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]

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(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]

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(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 dm^3 of hydrogen (measured at 25 °C and 1 atm) and one other product.

(i) Calculate the molar ratio of the three named substances. [3]

(ii) One other product is formed.

Determine the formula of this product by writing an equation for the decomposition reaction. [1]

.....

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(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.

$$2Li + 2H_2O \longrightarrow 2LiOH + H_2$$

Calculate the volume of hydrogen formed in cm^3. [4]

Volume of hydrogen = ... cm^3

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

$$CH_4 + H_2O \rightleftharpoons 3H_2 + CO$$

(i) Write an expression for the equilibrium constant, K_c, and give its unit, if any. [2]

K_c =

Unit .....

(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. [2]

Concentration of methane = ... mol dm^{-3}

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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 as follows.

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$$

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

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

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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.

[6 QER]

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(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]

.....

.....

(ii) The first property listed above 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]

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(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}. [2]

Volume of water added = ... cm^3

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(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. [2]

$[H^+]$ = ... $mol\,dm^{-3}$

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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