Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS

B410U10-1

S24-B410U10-1

TUESDAY, 14 MAY 2024 – MORNING

CHEMISTRY – AS component 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 5.	10	
Section B 6.	9	
7.	14	
8.	6	
9.	10	
10.	21	
11.	10	
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 **Q7**(a)(iv).

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SECTION A

Answer **all** questions.

1. Silver chloride can be precipitated by the following reaction.

$$AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$$

M_r 170 M_r 58.5 M_r 143.5 M_r 85

Calculate the atom economy for the production of silver chloride. [1]

Atom economy = ... %

2. When phosphoric(V) acid, H_3PO_4, is neutralised with sodium hydroxide, sodium phosphate is produced.

Complete and balance the equation for the reaction. [2]

..... $NaOH + H_3PO_4 \longrightarrow$ ..... + ... H_2O

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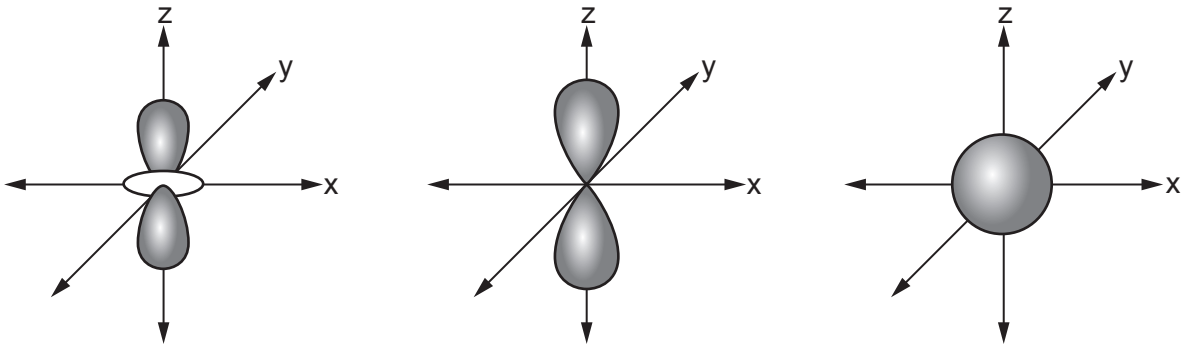
3. There are four types of orbitals found in an atom – *s*, *p*, *d* and *f*.

(a) Give the meaning of the term orbital. [1]

.....

.....

(b) Identify the shape of a *p*-orbital by circling the correct diagram. [1]



4. Calcium hydroxide decomposes on heating as shown below.

$$Ca(OH)_2(s) \longrightarrow CaO(s) + H_2O(g)$$

Calculate the maximum mass of calcium oxide that can be produced when 75.0 g of calcium hydroxide is heated. [2]

Mass of calcium oxide = ... g

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5. Esters are made by the reaction of carboxylic acids with alcohols. Once the reagents are mixed the reaction is left to reach dynamic equilibrium.

(a) Give the meaning of the term dynamic equilibrium. [1]

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(b) An example of an esterification reaction is given below.

$$CH_3OH + HCOOH \rightleftharpoons HCOOCH_3 + H_2O$$

Write an expression for K_c, the equilibrium constant, for this reaction.

Give the unit, if any, for K_c. [2]

Unit .....

10

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SECTION B

Answer **all** questions.

6. This question is about some aspects of the chemistry of the noble gases.

(a) Explain why the noble gases exist as monatomic particles. [2]

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(b) Explain why argon has a very low boiling temperature. [1]

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(c) The first ionisation energy of argon is 1521 kJ mol^{-1}.

Calculate the frequency of the high energy photon needed to ionise an Ar atom to form an Ar^+ ion. Give your answer in **MHz**. [3]

Frequency = ... MHz

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(d) There are many radioactive isotopes of radon. The most stable has a relative isotopic mass of 222.

(i) Give the meaning of the term relative isotopic mass. [1]

.....

.....

(ii) Write an equation for the formation of ^{218}Po by the radioactive decay of ^{222}Rn. [2]

.....

9

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7. (a) Carbon forms covalent bonds in trichloromethane and diamond.

(i) Give the meaning of the term covalent bond. [1]

.....

.....

(ii) Draw a dot and cross diagram to show the bonding in trichloromethane, $CHCl_3$. Show outer electrons only. [2]

(iii) A student proposed that the $Cl-\hat{C}-Cl$ bond angle in trichloromethane must be slightly larger than the $H-\hat{C}-Cl$ bond angle.

Suggest a reason why this might be true. [1]

.....

.....

.....

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(iv) The melting temperature of diamond is over 4000 °C whereas the melting temperature of trichloromethane is only –63.5 °C.

Compare and contrast the structures of trichloromethane and diamond. Explain why the melting temperature of diamond is so high compared to that of trichloromethane. [6 QER]

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(b) Boron is in Group 3 of the Periodic Table.

(i) Explain why the bond angles in boron trifluoride, BF_3, are exactly 120°. [2]

.....

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(ii) Boron trifluoride forms a compound with ammonia, NH_3.

Suggest how a bond forms between the nitrogen atom and the boron atom. [2]

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14

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8. Gold leaf is gold that has been hammered into very thin sheets and it is usually 0.1 μm thick.

(a) Explain why gold is malleable. [1]

.....

.....

(b) The density of pure gold is 19.32 g cm^{-3}.

(i) Calculate the number of gold atoms present in a square of pure gold leaf that is 3.0 cm $\times$ 3.0 cm and 0.1 μm thick. [3]

Number of atoms = ...

(ii) Pure gold is 24-karat but the most commonly used gold is 22-karat yellow gold.

Calculate the number of moles of gold in a 1.0 cm **cube** of 22-karat yellow gold. [2]

Number of moles = ... mol

6

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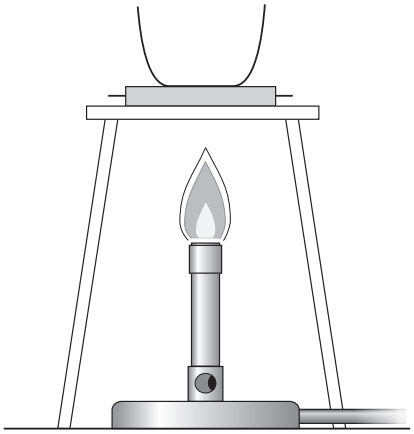
9. When calcium carbonate is heated the following reaction occurs.

$$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$$

(a) Name this type of reaction. [1]

.....

(b) This reaction was carried out in a laboratory using the apparatus shown.



The following results were obtained.

Mass of empty crucible / g	9.732
Mass of crucible and $CaCO_3$ / g	9.908
Mass of crucible and CaO / g	9.842

(i) The reaction did not go to completion.

I. Calculate the maximum possible number of moles of carbon dioxide that could be produced. [1]

Moles of carbon dioxide = ... mol

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II. Calculate the percentage yield of carbon dioxide in this reaction. [2]

Yield = ... %

(ii) Describe and explain how the yield of calcium oxide can be maximised. [2]

.....

.....

.....

(c) Calculate the volume occupied by 3.75×10^{-3} mol of carbon dioxide at a temperature of 800 °C and 2 atm pressure. Give your answer in **cm^3**. [4]

Volume = ... cm^3

10

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10. (a) A student wanted to make a solution of magnesium sulfate.

Give a description, including quantities, of how she could make 250 cm^3 of an aqueous solution of 1.00 mol dm^{-3} magnesium sulfate (M_r 120.4). [4]

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(b) The solution she obtained was slightly cloudy. Analysis showed that the original solid was contaminated with magnesium hydroxide.

(i) Give a reason why the solution appeared cloudy. [1]

.....

(ii) She decided to assess the level of impurity by carrying out a back titration.

She added 0.50 g of the impure magnesium sulfate to 100 cm^3 of 0.40 mol dm^{-3} hydrochloric acid. She then titrated 25.0 cm^3 samples of her solution against 1.00 mol dm^{-3} aqueous sodium hydroxide.

Her results are given in the table.

Titration number	1	2	3
Final burette reading / cm^3	9.20	18.30	27.50
Initial burette reading / cm^3	0.00	9.20	18.30
Titre / cm^3	.....	.....	.....

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I. Complete the table and use the data to calculate a mean titre. [1]

Mean titre = ... cm^3

II. Calculate the number of moles of hydrochloric acid that reacted with the impure magnesium sulfate sample. [3]

Moles of HCl = ... mol

III. Hydrochloric acid reacts with magnesium hydroxide as shown.

$$2HCl + Mg(OH)_2 \longrightarrow MgCl_2 + 2H_2O$$

Calculate the percentage purity by mass of the impure magnesium sulfate. [3]

Purity = ... %

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IV. Calculate the percentage error in the titre value of titration number 1. [1]

Percentage error = ... %

V. The student realised that this percentage error was significant and decided to repeat the experiment using hydrochloric acid of concentration 1.00 mol dm^{-3} instead of the original 0.40 mol dm^{-3}.

State whether or not this change would reduce the percentage error.

Justify your answer by calculating and commenting upon the new titre value. [4]

New titre value = ... cm^3

.....

.....

(iii) State how a flame test could be used to prove that the impurity was **not** calcium hydroxide. [1]

.....

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(iv) I. Calculate the pH of 0.40 mol dm^{-3} hydrochloric acid. [1]

pH = ...

II. Suggest how the pH of 0.40 mol dm^{-3} sulfuric acid would differ, if at all, from the pH of 0.40 mol dm^{-3} hydrochloric acid.

Justify your answer. [2]

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21

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11. Bromine can be extracted from seawater and other water sources by the oxidation of bromide ions.

(a) Write a half-equation for the oxidation of bromide ions. [1]

.....

(b) State why this reaction is described as an oxidation reaction. [1]

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(c) Chlorine can be used as an oxidising agent.

Explain why chlorine can oxidise bromide ions. [1]

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(d) The concentration of bromide ions in seawater from the Dead Sea can be as high as $12\,g\,dm^{-3}$.

Calculate the maximum number of moles of bromine that can be extracted from $4500\,m^3$ of this seawater. [2]

Number of moles = ... mol

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(e) A student decided to investigate other halogen-halide reactions under standard laboratory conditions.

(i) He added an aqueous solution of iodine to an aqueous solution of potassium bromide. He observed a brown colour in the test tube.

He decided that the brown colour was due to the formation of bromine.

Explain why the student is incorrect. [2]

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(ii) The halogen can be identified by shaking the reaction mixture with cyclohexane. Two layers form and the purple colour of the cyclohexane layer shows that iodine is present.

Explain why iodine is more soluble in cyclohexane than in water. [3]

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END OF PAPER

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