Surname	Centre Number	Candidate Number
First name(s)		2

GCE AS

B410U10-1

O20-B410U10-1

Part of WJEC

TUESDAY, 6 OCTOBER 2020 – AFTERNOON

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 7.**	**10**	
Section B	**8.**	**16**	
	9.	**10**	
	10.	**12**	
	11.	**9**	
	12.	**11**	
	13.	**12**	
	Total	**80**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Booklet** supplied by WJEC.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

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 **Q.8***(b)*.

If you run out of space, use the continuation page(s) at the back of the booklet, taking care to number the question(s) correctly.

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SECTION A

Answer **all** *questions in the spaces provided.*

1. Complete the electronic configuration of the Se^{2-} ion. [1]

$1s^2 2s^2$ .....

2. What is the oxidation state of sulfur in the SO_4^{2-} ion? [1]

.....

3. Under certain conditions the following equilibrium exists.

$$2N_2O_5(g) \rightleftharpoons 4NO_2(g) + O_2(g)$$

(a) Write the expression for the equilibrium constant, K_c, for this equilibrium. [1]

K_c =

(b) State the unit, if any, for K_c in this equilibrium. [1]

.....

4. A radioactive isotope has a half-life of 4 hours. Calculate the time needed for 4.0 g of the isotope to decay to 0.5 g. [1]

Time = ... hours

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5. Water gas is a mixture of carbon monoxide and hydrogen that is made by passing steam over heated carbon.

$$H_2O(g) + C(s) \longrightarrow H_2(g) + CO(g)$$

Calculate the atom economy of this process as a method for the production of hydrogen gas. [2]

Atom economy = ... %

6. Balance the following equation. [1]

3 K_2CO_3 + ... $AlCl_3$ + ... H_2O ⟶ ..... KCl + ... $Al(OH)_3$ + ... CO_2

7. *(a)* State the meaning of the term *electronegativity*. [1]

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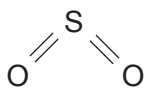
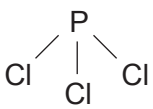
(b) On the diagrams below mark any permanent dipoles. [1]





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SECTION B

Answer **all** *questions in the spaces provided.*

8. *(a)* State the meaning of the term *molar first ionisation energy*. [2]

.....

.....

(b) Students using a spectrometer observed lines from a hydrogen lamp in the visible part of the spectrum.

One student said that the frequencies of the lines could be used to calculate the molar first ionisation energy of hydrogen. The other student said that these were not the lines needed in this calculation.

Comment on these statements and explain how the molar first ionisation energy of hydrogen can be determined. [6 QER]

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(c) A line in a spectrum has a wavelength of 550 nm.

Calculate the energy change, in kJ mol^{-1}, that corresponds to this line. [4]

Energy change = ... kJ mol^{-1}

(d) The table shows the first ionisation energy for some elements.

Element	First ionisation energy / kJ mol^{-1}
sodium, Na	496
magnesium, Mg	738
potassium, K	419

(i) Explain the difference in the values for sodium and magnesium. [2]

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(ii) Explain the difference in the values for sodium and potassium. [2]

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9. Hydrazine, N_2H_4, is a liquid that can be used as a rocket fuel. It reacts with oxygen in an exothermic reaction.

$$N_2H_4(l) + O_2(g) \longrightarrow N_2(g) + 2H_2O(g)$$

(a) (i) A molecule of hydrazine contains single bonds only.

Draw a dot and cross diagram to show the arrangement of the electrons in hydrazine. You should show outer electrons only. [2]

(ii) Suggest the bond angle for the H — N — H bonds in hydrazine. Explain your suggestion. [3]

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(b) Calculate the volume of nitrogen produced by the reaction of 20.0 cm^3 of liquid hydrazine with excess oxygen.

Assume that all measurements are taken at 273 K and 1 atm pressure, that the density of hydrazine is 1.02 g cm^{-3} and that the process has a 35 % yield. [4]

Volume = ... dm^3

(c) Methane also reacts with oxygen in an exothermic reaction and could be used as a rocket fuel. Apart from conservation of fossil fuel reserves, suggest an environmental advantage of using hydrazine. [1]

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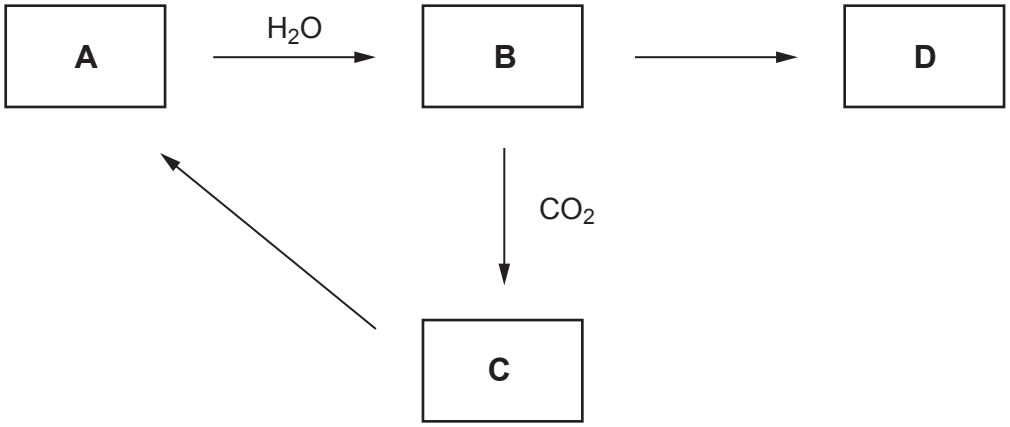
10. Some reactions of compounds of the same s-block metal are shown below.



A is a compound that reacts with water to give an aqueous solution of the sparingly soluble compound **B**.

B reacts with carbon dioxide to give a white precipitate of compound **C**.

D is an aqueous solution that gives a white precipitate with aqueous silver nitrate.

(a) Give the names of compounds **A** to **D**. [4]

A .....

B .....

C .....

D .....

(b) Suggest a reagent that would convert **B** into **D**. [1]

.....

(c) State how the conversion of **C** into **A** could be carried out. [1]

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(d) Write the **ionic** equation for the conversion of **A** into **B**. Include state symbols. [2]

.....

(e) What would be observed, if anything, if aqueous sodium hydroxide were added dropwise and then to excess to solution **D**? [2]

Dropwise .....

Excess .....

(f) Suggest a test that would confirm the cation present in compounds **A** to **D**. Include the test and the expected result. [2]

Test .....

Result .....

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11. Explain the following statements.

(a) Bromine is a liquid at room temperature and iodine is a solid. [3]

(b) Graphite conducts electricity but diamond does not. [3]

(c) The molecular ion peaks are at m/z 158, 160 and 162 in the mass spectrum of bromine, Br_2. The areas of these peaks are in the ratio of 1 : 2 : 1. [3]

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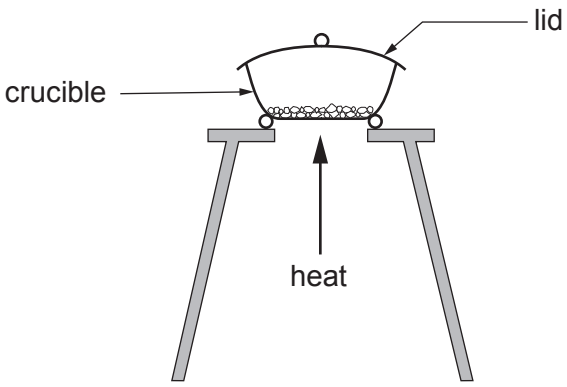
12. Barium chloride exists as a hydrated salt, $BaCl_2.xH_2O$, where x is the number of molecules of water of crystallisation. To determine the value of x, the hydrated salt is heated to remove the water of crystallisation.

The following method was carried out.

- Weigh an empty crucible with its lid.
- Place about 2.00 g of hydrated barium chloride in the crucible and re-weigh, with its lid.
- Place the lid on the crucible and heat gently at first, then remove the lid and heat strongly for about 2 minutes.



- Place the lid on the crucible and allow it to cool.
- Weigh the cooled crucible with its lid and residue.

The following results were recorded.

Mass of crucible + lid = 10.24 g

Mass of crucible + lid + hydrated barium chloride = 12.25 g

Mass of crucible + lid + residue after heating = 11.97 g

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(a) Calculate the mass of hydrated barium chloride and the mass of residue. Hence determine the value of x. [5]

x = ...

(b) (i) Suggest why the crucible was heated initially with the lid in place. [1]

.....

.....

(ii) Suggest why the lid was placed on the crucible when it was left to cool. [1]

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.....

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(c) (i) When this experiment is carried out the value of x obtained is often less than the theoretical value. Suggest a reason for this, assuming that the compound contains no impurities. [1]

.....

.....

(ii) State an improvement that could be made to the practical procedure to overcome the problem you have identified in *(c)*(i). [1]

.....

.....

(d) If the error in each balance reading is ± 0.05 g, calculate the percentage error in the mass of hydrated barium chloride used in the experiment. [1]

Percentage error = ... %

(e) Apart from the improvement you identified in *(c)*(ii), suggest another change that could be made to improve the accuracy of the experiment. [1]

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TURN OVER FOR QUESTION 13

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13. *(a)* A compound of carbon, hydrogen and oxygen contains 40.0 % carbon and 6.7 % hydrogen by mass.

1.52 g of the gaseous compound has a volume of 1.76 dm^3 at a temperature of 150 °C and a pressure of 1 atm.

Use the data to determine the empirical formula and the molecular formula of this compound. You **must** show clearly how you carried out your calculations. [5]

Empirical formula .....

Molecular formula .....

(b) (i) State what is meant by an acid. [1]

.....

(ii) Describe how ammonia, NH_3, is able to act as a base. [2]

.....

.....

.....

(iii) Calculate the pH of 0.43 mol dm^{-3} hydrochloric acid. [2]

pH = ...

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(c) In the table below name the type of structure and bonding present in magnesium oxide, MgO, and chlorine dioxide, ClO_2. [2]

Compound	Structure	Bonding
MgO	.....	.....
ClO_2	.....	.....

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END OF PAPER

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For continuation only.

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