Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A LEVEL – NEW

2410U10-1

S17-2410U10-1

CHEMISTRY – AS unit 1
The Language of Chemistry, Structure of Matter and Simple Reactions

FRIDAY, 26 MAY 2017 – MORNING

1 hour 30 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1. to 5.**	**10**	
Section B	**6.**	**20**	
	7.	**15**	
	8.	**17**	
	9.	**18**	
	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. Do not use gel pen or correction fluid.

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.9***(a)*.

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.

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SECTION A

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

1. Using **outer** electrons only, draw a dot and cross diagram to show the bonding in calcium bromide. [2]

2. Identify the **two** elements from the following list that together produce the most ionic bond. Explain your choice.

bromine magnesium oxygen sodium [2]

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3. *(a)* State how a coordinate bond differs from a covalent bond. [1]

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(b) Give **one** example of a species containing a coordinate bond. [1]

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4. There are 33 known isotopes of krypton. One of the isotopes – ^{81}Kr – decays by electron capture.

(a) Write an equation to show this decay. [1]

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(b) Krypton-81 has been used for dating old groundwater. It takes 6.87×10^5 years for 2.0 g of ^{81}Kr to decay to 0.25 g. Calculate its half-life. [1]

Half-life = ... years

5. Boron has a relative atomic mass of 10.8. It has only two naturally-occurring isotopes, one of which has an abundance of 80.0 % and a mass of 11. Calculate the mass of the second isotope. [2]

Mass = ...

10

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SECTION B

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

6. *(a)* The atomic spectrum of hydrogen consists of several separate series of lines.

(i) In the Balmer series, when an electron returns from the third shell to the second shell, a red line is seen at a wavelength of 656 nm. Calculate the energy of the radiation emitted at this wavelength. [3]

Energy = ... J

(ii) Explain how the Lyman series can be used to calculate the ionisation energy of hydrogen. [2]

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(b) State and explain how you would expect the ionisation energy of hydrogen to compare with the first ionisation energy of:

(i) helium [2]

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(ii) lithium [2]

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(c) (i) On adding a strip of magnesium to hydrochloric acid, 125 cm^3 of hydrogen gas formed at a temperature of 24 °C and a pressure of 1.01×10^5 Pa. Calculate the volume occupied by this gas under the same pressure and at a temperature of 52 °C. [2]

Volume = ... cm^3

(ii) In another experiment, 160 cm^3 of hydrogen formed at 20 °C and 1.01×10^5 Pa. Assuming that hydrogen behaves as an ideal gas, calculate the amount, in moles, of hydrogen formed. [3]

n = ... mol

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(d) Hydrogen can form a range of covalent hydrides such as water, H_2O, and beryllium hydride, BeH_2. A student said that since the ratio of hydrogen to the other element is the same in both compounds, the shapes of the two compounds will be the same. Is she correct? Justify your answer. [3]

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(e) (i) On forming ice at 0 °C, 50.0 cm^3 of water expands to occupy 54.5 cm^3. Calculate the density of ice at 0 °C. [2]

Density = ... $g\,cm^{-3}$

(ii) Explain why ice and water have different densities at 0 °C. [1]

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20

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7. *(a)* A student is asked to prepare a standard solution of sodium carbonate of concentration 0.0500 mol dm^{-3}.

The first step involved in the preparation of a standard solution is to weigh the appropriate mass of solid in a weighing bottle.

Calculate the mass of sodium carbonate required and describe the remaining steps that the student should take to prepare 250 cm^3 of this standard solution. [6]

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(b) The standard solution prepared in part *(a)* was used to determine the concentration of dilute hydrochloric acid.

25.0 cm^3 samples of the sodium carbonate solution were titrated against the hydrochloric acid. These were the results.

Titration	1	2	3	4
Final reading / cm^3	26.50	26.80	26.20	26.55
Initial reading / cm^3	0.40	0.15	0.00	0.25
Titre / cm^3	26.10	26.65	26.20	26.30

(i) Calculate the mean titre that should be used to determine the concentration of the hydrochloric acid. [1]

Mean titre = ... cm^3

(ii) The burette used in the titrations has an uncertainty for each reading of ±0.05 cm^3. Estimate the maximum percentage error in the **titre** in titration 4. Show your working. [1]

Percentage error = ... %

(iii) Apart from errors in reading the burette, suggest **one** reason why incorrect titres may have been obtained when carrying out the titrations. Explain the effect of this error on the value of the titre obtained. [2]

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(c) A student wanted to verify that the ammonium sulfate content in a fertiliser was as given on the packet.

He boiled 4.24 g of the fertiliser with 50.0 cm^3 of 1.00 mol dm^{-3} sodium hydroxide solution until no more ammonia was evolved.

The residual solution containing excess sodium hydroxide was made up to 250 cm^3 with distilled water in a standard volumetric flask. A 25.0 cm^3 portion of this solution required 22.65 cm^3 of 0.090 mol dm^{-3} hydrochloric acid for neutralisation.

(i) Calculate the number of moles of sodium hydroxide in the 250 cm^3 flask and hence the number of moles that reacted with the fertiliser. [3]

n(NaOH) = ... mol

(ii) The equation for the reaction between ammonium sulfate and sodium hydroxide is:

$$(NH_4)_2SO_4 + 2NaOH \longrightarrow 2NH_3 + Na_2SO_4 + 2H_2O$$

Use your answer to part (i) to calculate the percentage by mass of ammonium sulfate in the fertiliser. [2]

Percentage = ... %

15

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8. *(a)* Copper can be extracted from the mineral chalcopyrite. The mineral is smelted by heating with air. The equation for this reaction is as follows.

$$4CuFeS_2 + \ldots\ldots O_2 \longrightarrow \ldots\ldots Cu + \ldots\ldots FeO + \ldots\ldots Fe_2O_3 + \ldots\ldots SO_2$$

(i) Balance the equation above. [1]

(ii) Give the full electronic configuration of a copper atom. [1]

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(iii) A sample of rock contains 1.30 % by mass of chalcopyrite. Assuming this is the only source of copper in the rock, calculate the percentage by mass of copper in the sample. [2]

Percentage = ... %

(iv) During the smelting Cu_2S is produced. This is collected and blown with air to produce copper.

$$Cu_2S + O_2 \longrightarrow 2Cu + SO_2$$

This is classified as a redox reaction. Use oxidation numbers to explain which elements have been oxidised and which reduced. [3]

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(b) Sulfur dioxide can react with oxygen and water to form sulfuric acid. Although sulfuric acid is a strong acid, it does not have to be a concentrated acid.

Explain the difference between the terms *strong acid* and *concentrated acid.* [2]

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(c) (i) A student was given an aqueous solution of an acid HX and was asked to find out if it was a strong or weak acid. 25.0 cm^3 of the acid HX required 15.90 cm^3 of 0.0125 mol dm^{-3} sodium hydroxide solution for complete neutralisation.

Calculate the concentration of the acid. Assume that HX reacts with the sodium hydroxide in a 1:1 molar ratio. [2]

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

(ii) A teacher measured the pH of the aqueous solution and found it to be 2.10. She told the student that the acid in the solution must be a strong one. Is she correct? Justify your answer. [2]

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(d) The commonest complex ion that copper forms in solution is the hexaaquacopper(II) ion, $[Cu(H_2O)_6]^{2+}$. If concentrated hydrochloric acid is added to a solution containing hexaaquacopper(II) ions a new complex forms as the following equilibrium is established.

$$[Cu(H_2O)_6]^{2+}(aq) + 4Cl^-(aq) \rightleftharpoons [CuCl_4]^{2-}(aq) + 6H_2O(l)$$

blue yellow-green

The forward reaction is endothermic.

(i) State and explain what you would observe on adding water to the equilibrium mixture. [2]

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(ii) State and explain what you would observe on heating the equilibrium mixture. [2]

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9. *(a)* A student is given five beakers labelled **A**, **B**, **C**, **D** and **E**. Each contains a different solution. The solutions are barium bromide, barium nitrate, calcium chloride, magnesium chloride and magnesium nitrate but it is not known which beaker contains which solution.

She is also given solutions of three reagents: silver nitrate, sodium hydroxide and sulfuric acid.

Devise a plan that uses the reagents to unambiguously determine which solution is in which beaker.

You should include the observations that enable you to positively identify **all** five solutions.
[6 QER]

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(b) Give a test which would confirm the presence of calcium ions in aqueous calcium chloride. State the result of the test. [2]

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(c) A solution is known to contain a mixture of sodium carbonate and sodium nitrate only. To determine the carbonate ion concentration in the mixture, aqueous barium chloride was added in excess. The precipitate produced was filtered off and dried by strong heating.

(i) Write the **ionic** equation, including state symbols, for this precipitation reaction. [1]

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(ii) State why the aqueous barium chloride was added in excess. [1]

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(d) All Group 2 carbonates are insoluble and can be precipitated, dried and weighed in experiments similar to that in part *(c)*. However, the strong heating needed to drive off all the water can cause a problem in accurately determining the mass of the carbonate precipitated. Suggest what this problem might be. [2]

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(e) Explain the following observations by reference to the bonding present in each of the substances.

(i) Ionic substances such as calcium chloride can conduct electricity under certain circumstances. [2]

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(ii) Iodine is a solid which vaporises on gentle warming. [2]

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(iii) A metal such as magnesium is malleable. [2]

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END OF PAPER

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

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