Surname	Centre Number	Candidate Number
Other Names		2

GCE AS – NEW AS

B410U10-1

S16-B410U10-1

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

A.M. FRIDAY, 27 May 2016

1 hours 30 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1. to 8.**	**10**	
Section B	**9.**	**10**	
	10.	**12**	
	11.	**10**	
	12.	**12**	
	13.	**14**	
	14.	**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.12***(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. Complete the electronic structure for a vanadium, V, atom. [1]

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

2. Draw a dot and cross diagram to show the formation of sodium sulfide. Show the outer electrons only. [2]

3. Complete the equation below to show one form of radioactive decay. [1]

$^{23}_{12}Mg \longrightarrow$ ..... + e^+

4. Hydrogen sulfide reacts with sulfur dioxide.

$$2H_2S(g) + SO_2(g) \longrightarrow 2H_2O(l) + 3S(s)$$

Show, using oxidation states, that this is a redox reaction. [1]

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5. What is meant by the *Avogadro constant*? [1]

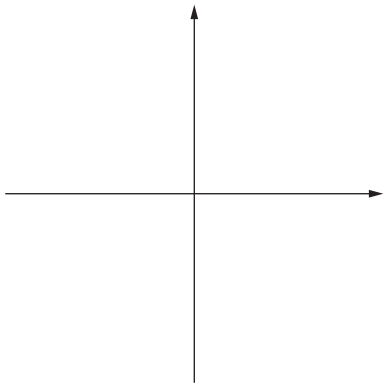
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6. Draw the shape of a 2p orbital on the axes below. [1]



7. Aspirin can be prepared by the reaction shown below.

$$C_6H_4(OH)COOH + (CH_3CO)_2O \longrightarrow \underset{\text{aspirin}}{C_6H_4(OCOCH_3)COOH} + CH_3COOH$$

Calculate the atom economy of this reaction. [2]

Atom economy = ... %

8. Give a reason why some covalent bonds are polar. [1]

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SECTION B

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

9. A mass spectrometer can be used to find relative atomic mass, A_r, and relative molecular mass, M_r.

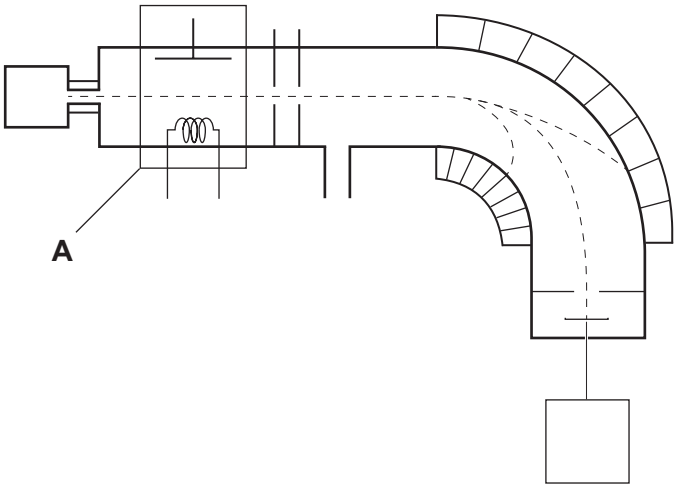
(a) Define *relative atomic mass*. [2]

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(b) The diagram shows one type of mass spectrometer.



(i) On the diagram label the magnet. [1]

(ii) Explain what is happening in the mass spectrometer in the region labelled **A**. [2]

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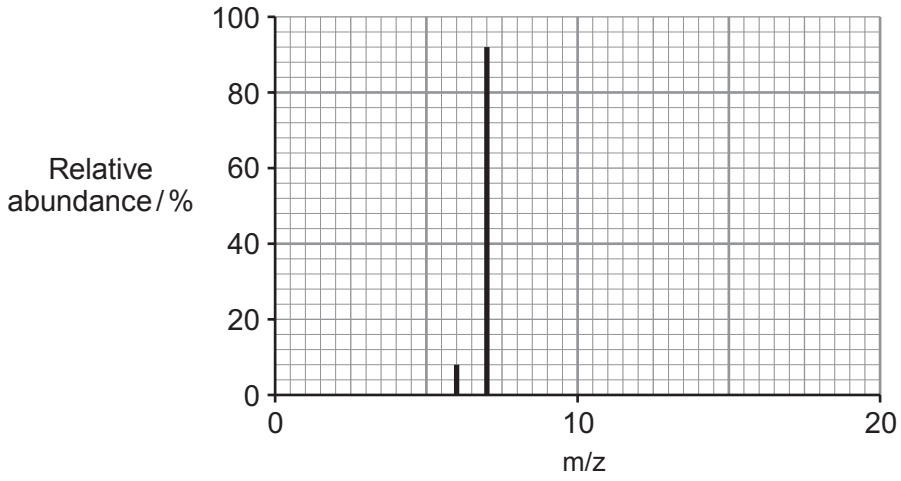
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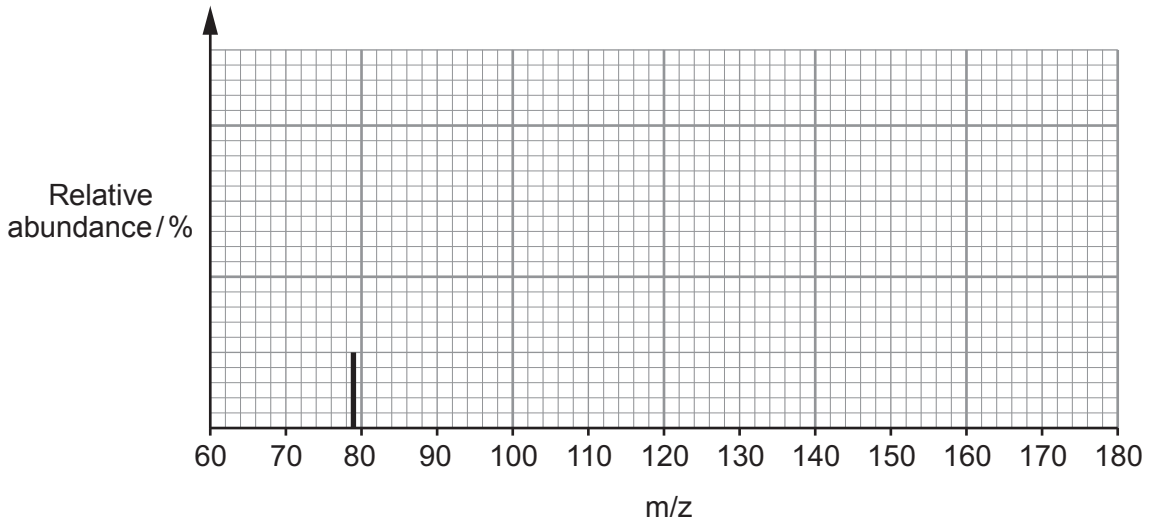
(c) The mass spectrum below was obtained from a sample of lithium.

Use the spectrum to calculate the relative atomic mass for this sample of lithium. Give your answer to **three** significant figures. [2]



Relative atomic mass = ...

(d) Bromine exists as two isotopes with mass numbers 79 and 81. In a sample of bromine, Br_2, there are approximately the same amounts of each isotope. On the mass spectrum below, sketch lines to complete the mass spectrum that this sample of bromine would be expected to give. [3]



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10. Using ideas that you have studied in your Chemistry course comment on and explain the following observations.

(a) In sodium chloride and caesium chloride the arrangements of the particles in the solids are different. [4]

(b) Hydrogen sulfide, H_2S, is a gas at room temperature and pressure but water, H_2O, is a liquid under the same conditions. [4]

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(c) The bond angles in the PCl_4^+ ion are greater than the bond angles in the PCl_6^- ion. [4]

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11. **X** and **Y** are metals that are in the **same group** of the Periodic Table. Aqueous solutions of a salt of each metal were added to three aqueous laboratory reagents. The observations made are shown in the table.

	$H_2SO_4(aq)$	NaOH(aq)	$Cl_2(aq)$
Salt of **X**	white precipitate	no visible reaction	orange/brown solution
Salt of **Y**	no visible reaction	white precipitate	orange/brown solution

(a) Suggest the identity of metal **X** and metal **Y**. Explain your reasoning. [3]

X is .....

Y is .....

Explanation

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(b) (i) Using the symbol **X** for the metal, write the **ionic** equation for the reaction of the salt of **X** with dilute sulfuric acid. Include state symbols. [1]

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(ii) Using the symbol **Y** for the metal, write the **ionic** equation for the reaction of the salt of **Y** with aqueous sodium hydroxide. Include state symbols. [1]

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(c) (i) Explain what happens when aqueous chlorine is added to solutions of the salts of **X** and **Y**. [3]

You should include:

- the identity of the orange/brown product
- the nature of the reaction occurring
- a suggested identity for the anion present in both salts

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(ii) Describe a test that you could carry out on the salt solutions to confirm the identity of this anion. Include the observation expected in the test. [2]

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Turn over.

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12. David said that sodium compounds give a yellow flame test because the heat makes the atoms move faster. He also said that the yellow flame was the sodium absorption spectrum consisting of one line because the atoms take in light of just one energy.

(a) Discuss how far you agree with David's statement and correct any errors which he has made. You should include the chemical principles involved. [6 QER]

(b) A white solid is known to be either a magnesium or a potassium compound. Describe how you could carry out a flame test to identify the metal ion present. You should include the expected result for each compound. [2]

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(c) (i) A line in a visible spectrum was observed at a wavelength of 500 nm. Calculate the energy involved in the formation of this line. Give your answer with its unit and in standard form. [3]

Energy = ...

Unit = ...

(ii) A line in another spectrum was found to have a higher energy associated with its formation so that it was no longer visible. In which part of the electromagnetic spectrum would it be found? [1]

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13. *(a)* A student was told that a bottle of hydrochloric acid he was given was approximately of concentration 0.1 mol dm^{-3}. He was asked to determine the accurate concentration of the acid using a titration method. He had access to solid anhydrous sodium carbonate, Na_2CO_3, and the apparatus normally found in a school or college laboratory.

(i) Write the equation for the reaction between sodium carbonate and hydrochloric acid. [1]

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(ii) Describe how the student should carry out the determination of the concentration of the acid. You should include the apparatus required and the **masses** and **volumes** of any chemicals used.

I. Outline the preparation of a solution of sodium carbonate suitable for use in a titration against the hydrochloric acid. [3]

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II. Describe how the student should carry out the titration to determine the concentration of the acid. You do not need to describe how the apparatus is cleaned or set up. [3]

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(b) The student found in *(a)* that the hydrochloric acid had a concentration of 0.110 mol dm^{-3}. Calculate the pH of this solution. [2]

pH = ...

(c) Another student was given a sample of ore containing compounds of silver and was asked to find the percentage of silver in the ore.

He dissolved 2.48 g of the silver ore in nitric acid and added excess of the hydrochloric acid to precipitate the silver as silver chloride. He filtered off the precipitate of silver chloride and found its mass.

(i) State how the precipitate was treated in order to obtain the mass of the silver chloride. Explain why the precipitate was treated in this way. [2]

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(ii) Write the **ionic** equation for the formation of this precipitate. Include state symbols. [1]

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(iii) The mass of silver chloride obtained was 0.93 g. Calculate the percentage of silver in the ore. [2]

Percentage = ... %

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14. Emily was investigating the reversible reaction between methanol and ethanoic acid.

$$CH_3OH(l) + CH_3COOH(l) \rightleftharpoons CH_3COOCH_3(l) + H_2O(l)$$ **Reaction 1**

She followed these instructions.

- Heat 16.0 g of methanol with 36.0 g of ethanoic acid under reflux for one hour so that the reaction reaches equilibrium.
- Titrate the contents of the flask with aqueous sodium hydroxide. Complete this titration as quickly as possible.
- Note the volume of alkali used.

The equation for the reaction with sodium hydroxide is as follows.

$$CH_3COOH(l) + NaOH(aq) \longrightarrow CH_3COONa(aq) + H_2O(l)$$

(a) Write the expression for the equilibrium constant, K_c, for the reaction between methanol and ethanoic acid, **Reaction 1**. [1]

(b) Emily calculated that she had used 0.220 mol of sodium hydroxide in her titration. How many moles of ethanoic acid were present in the flask at equilibrium? [1]

Number of moles of acid = ...

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(c) Emily also calculated that there were 0.12 mol of methanol in the flask at equilibrium. Her teacher told her that the equilibrium constant, K_c, for this reaction is 5.47.

Emily looks at the equation for the equilibrium and sees that the number of moles of ester, CH_3COOCH_3, and water at equilibrium would be the same.

Use these data, and the value found in *(b)*, to calculate the number of moles of ester present at equilibrium. In this reaction you should assume that the concentration, in mol dm^{-3}, is equal to the number of moles of each substance present. [3]

Number of moles of ester = ...

(d) Another student carried out a similar experiment to that above to determine the value of the equilibrium constant, K_c. However he refluxed the mixture for only 30 minutes. When he calculated the value of K_c he found it to have a significantly lower value than that found in data books.

Give a possible explanation for the difference in the value of K_c. [1]

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(e) Explain why the heating should be carried out under reflux. [1]

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(f) (i) Explain why the instructions said that the titration should be completed as quickly as possible. [2]

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(ii) What would be the effect on the value of K_c that Emily calculated if she took a long time carrying out the titration? Explain your answer. [1]

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(g) The value of K_c for this reaction decreases if the temperature at which it is carried out increases.

Deduce whether the forward reaction is exothermic or endothermic. Explain your reasoning. [2]

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END OF PAPER

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