Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
January 2001
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY CHM1
Unit 1 Atomic Structure, Bonding and Periodicity

Friday 12 January 2001 Morning Session

In addition to this paper you will require:
a Periodic Table;
a calculator.

Time allowed: 1 hour 30 minutes

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in **Section A** and **Section B** in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information

- The maximum mark for this paper is 90.
- Mark allocations are shown in brackets.
- This paper carries 30 per cent of the total marks for AS. For Advanced Level this paper carries 15 per cent of the total marks.
- You are expected to use a calculator where appropriate.
- The following data may be required.
  Gas constant $R = 8.31$ J mol^{-1} K^{-1}
- Your answers to questions in Section B should be written in continuous prose, where appropriate. You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.

Advice

- You are advised to spend about 1 hour on **Section A** and about 30 minutes on **Section B**.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
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Total (Column 1) →			
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SECTION A

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

1 (a) Give the relative mass and relative charge of a neutron.

Relative mass .....

Relative charge .....

(2 marks)

(b) In terms of the number of their fundamental particles, what do two isotopes of an element have in common and how do they differ?

In common .....

Difference .....

(2 marks)

(c) Give the complete atomic symbol, including mass number and atomic number, for an atom of the isotope with 22 neutrons and 19 electrons.

.....

(2 marks)

(d) In a mass spectrometer the isotopes of an element are separated and two measurements are made for each isotope.

(i) Which two measurements are made for each isotope?

Measurement 1 .....

Measurement 2 .....

(ii) State how the detector in a mass spectrometer works.

.....

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(iii) Why is a mass spectrometer incapable of distinguishing between the ions $^{14}N^{+}$ and $^{14}N_2^{2+}$?

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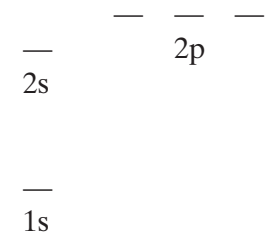
(5 marks)

(e) Using arrows ↑ and ↓ to represent electrons, complete the energy-level diagram below to show the electronic arrangement in an atom of carbon.



(2 marks)

(f) In terms of sub-levels, give the electronic configuration of the carbon ion C^{2+}

.....

(1 mark)

14

TURN OVER FOR THE NEXT QUESTION

2 (a) The mass of one atom of ^{12}C is 1.99×10^{-23}g. Use this information to calculate a value for the Avogadro constant. Show your working.

.....

.....

(2 marks)

(b) Give the meaning of the term *empirical formula*.

.....

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(1 mark)

(c) Define the term *relative molecular mass*.

.....

.....

.....

(2 marks)

(d) The empirical formula of a compound is CHO and its relative molecular mass has the value 174. Determine the molecular formula of this compound and show your working.

.....

.....

(2 marks)

(e) A compound with molecular formula CH_4O burns in air to form carbon dioxide and water. Write a balanced equation for this reaction.

.....

(1 mark)

8

3 Ammonium nitrate can be prepared by the reaction between ammonia and nitric acid:

$$NH_3 + HNO_3 \longrightarrow NH_4NO_3$$

(a) The concentration of a nitric acid solution is 2.00 mol dm^{-3}. Calculate the volume of this solution which would be required to react with exactly 20.0 g of ammonia.

.....

.....

.....

.....

(4 marks)

(b) A sample of ammonium nitrate decomposed on heating as shown in the equation below.

$$NH_4NO_3 \longrightarrow 2H_2O + N_2 + \tfrac{1}{2}O_2$$

On cooling the resulting gases to 298 K, the volume of nitrogen and oxygen together was found to be 0.0500 m^3 at a pressure of 95.0 kPa.

(i) State the ideal gas equation and use it to calculate the total number of moles of nitrogen and oxygen formed. (The gas constant R = 8.31 J mol^{-1} K^{-1})

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(ii) Using your answer to part (b)(i), deduce the number of moles of ammonium nitrate decomposed and hence calculate the mass of ammonium nitrate in the sample.

Moles of ammonium nitrate .....

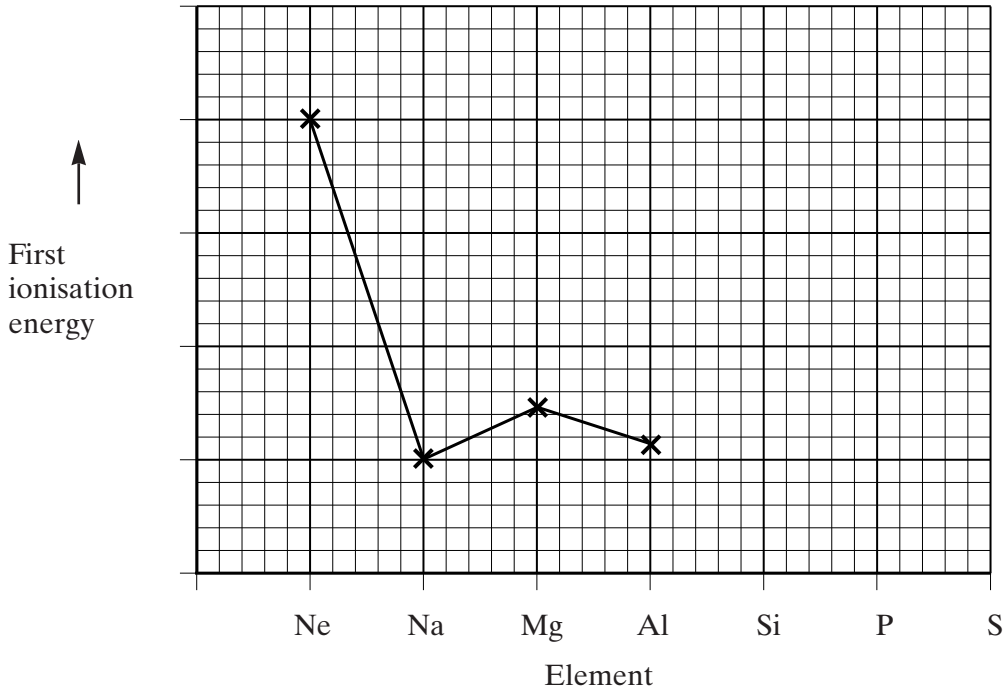
Mass of ammonium nitrate .....

.....

(6 marks)

10

4 The diagram below shows the trend in the first ionisation energies of the elements from neon to aluminium.



(a) Draw crosses on the graph to show the first ionisation energies of silicon, phosphorus and sulphur.

(3 marks)

(b) Write an equation to illustrate the process which occurs during the first ionisation of neon.

.....

(1 mark)

(c) Explain why the first ionisation energy of neon and that of magnesium are both higher than that of sodium.

Explanation for neon .....

.....

.....

Explanation for magnesium .....

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(4 marks)

(d) Explain why the first ionisation energy of aluminium is lower than that of magnesium.

.....

.....

(2 marks)

(e) State which one of the elements neon, sodium, magnesium, aluminium and silicon has the lowest melting point and explain your answer in terms of the structure and bonding present in that element.

Element with lowest melting point .....

Explanation .....

.....

.....

(3 marks)

(f) State which one of the elements neon, sodium, magnesium, aluminium and silicon has the highest melting point and explain your answer in terms of the structure and bonding present in that element.

Element with highest melting point .....

Explanation .....

.....

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(3 marks)

16

TURN OVER FOR THE NEXT QUESTION

5 (a) Define the term *electronegativity*.

.....

.....

(2 marks)

(b) State and explain the trend in electronegativity down Group II.

Trend .....

Explanation .....

.....

(3 marks)

(c) Write an equation for the reaction of strontium with water, and suggest an approximate value for the pH of the resulting solution.

Equation .....

pH .....

(2 marks)

(d) Describe what is seen when an aqueous solution of barium chloride is added to dilute sulphuric acid. Write an equation for the reaction which occurs.

Observation .....

Equation .....

(2 marks)

(e) Give two examples which illustrate the atypical properties of beryllium compounds in Group II.

Example 1 .....

Example 2 .....

(2 marks)

(f) Give one feature of the beryllium ion which causes the atypical properties of beryllium compounds.

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(1 mark)

12

SECTION B

Answer the question below in the space provided on pages 9 to 12 of this booklet.

6 (a) With the aid of diagrams, describe the structure of, and bonding in, crystals of sodium chloride, graphite and magnesium. In each case, explain how the melting point and the ability to conduct electricity of these substances can be understood by a consideration of the structure and bonding involved. *(23 marks)*

(b) Explain how the electron-pair repulsion theory can be used to predict the shapes of the molecules H_2O and PF_5. Illustrate your answer with diagrams of the molecules on which the bond angles are shown. *(7 marks)*

END OF QUESTIONS

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