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Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
June 2002
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY CHM1
Unit 1 Atomic Structure, Bonding and Periodicity

Wednesday 29 May 2002 Morning Session

In addition to this paper you will require:
the AQA Periodic Table (Reference CHEM/PT/EX);
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) The mass of one mole of ^{1}H atoms is 1.0078 g and that of one ^{1}H atom is 1.6734×10^{-24} g. Use these data to calculate a value for the Avogadro constant accurate to five significant figures. Show your working.

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(2 marks)

(b) How does the number of atoms in one mole of argon compare with the number of molecules in one mole of ammonia?

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(1 mark)

(c) A sample of ammonia gas occupied a volume of $0.0352\,m^3$ at 298 K and 98.0 kPa. Calculate the number of moles of ammonia in the sample.
(The gas constant $R = 8.31\,J\,K^{-1}\,mol^{-1}$)

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(3 marks)

(d) A solution containing 0.732 mol of ammonia was made up to 250 cm^3 in a volumetric flask by adding water. Calculate the concentration of ammonia in this final solution and state the appropriate units.

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(2 marks)

(e) A different solution of ammonia was reacted with sulphuric acid as shown in the equation below.

$$2NH_3(aq) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$$

In a titration, 25.0 cm^3 of a 1.24 mol dm^{-3} solution of sulphuric acid required 30.8 cm^3 of this ammonia solution for complete reaction.

(i) Calculate the concentration of ammonia in this solution.

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(ii) Calculate the mass of ammonium sulphate in the solution at the end of this titration.

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(6 marks)

(f) The reaction of magnesium nitride, Mg_3N_2, with water produces ammonia and magnesium hydroxide. Write an equation for this reaction.

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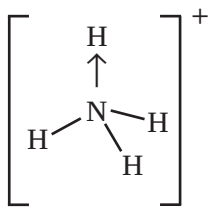
(2 marks)

16

2 (a) An ammonium ion, made by the reaction between an ammonia molecule and a hydrogen ion, can be represented as shown in the diagram below.



(i) Name the type of bond represented in the diagram by N—H

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(ii) Name the type of bond represented in the diagram by N→H

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(iii) In terms of electrons, explain why an arrow is used to represent this N→H bond.

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(iv) In terms of electron pairs, explain why the bond angles in the NH_4^+ ion are all 109° 28′

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(7 marks)

(b) Define the term *electronegativity*.

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(2 marks)

(c) A bond between nitrogen and hydrogen can be represented as $\overset{\delta-}{\text{N}}\!\!-\!\!\overset{\delta+}{\text{H}}$

(i) In this representation, what is the meaning of the symbol δ+ ?

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(ii) From this bond representation, what can be deduced about the electronegativity of hydrogen relative to that of nitrogen?

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(2 marks)

11

TURN OVER FOR THE NEXT QUESTION

3 The table below shows some values of melting points and some heat energies needed for melting.

Substance	I_2	NaCl	HF	HCl	HI
Melting point/K	387	1074	190	158	222
Heat energy for melting /kJ mol^{-1}	7.9	28.9	3.9	2.0	2.9

(a) Name **three** types of intermolecular force.

Force 1 .....

Force 2 .....

Force 3 .....

(3 marks)

(b) (i) Describe the bonding in a crystal of iodine.

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(ii) Name the crystal type which describes an iodine crystal.

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(iii) Explain why heat energy is required to melt an iodine crystal.

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(4 marks)

(c) In terms of the intermolecular forces involved, suggest why

(i) hydrogen fluoride requires more heat energy for melting than does hydrogen chloride,

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(ii) hydrogen iodide requires more heat energy for melting than does hydrogen chloride.

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(5 marks)

(d) (i) Explain why the heat energy required to melt sodium chloride is large.

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(ii) The heat energy needed to vaporise one mole of sodium chloride (171 kJ mol^{-1}) is much greater than the heat energy required to melt one mole of sodium chloride. Explain why this is so.

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(3 marks)

(e) In terms of its structure and bonding, suggest why graphite has a very high melting point.

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(2 marks)

Turn over ▶

4 (a) State the trend in atomic radius down Group II from Be to Ba and give a reason for this trend.

Trend .....

Reason .....

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(2 marks)

(b) State and explain the trend in melting points of the elements down Group II from Be to Ba.

Trend .....

Explanation .....

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(3 marks)

(c) State the trend in reactivity with water of the elements down Group II from Be to Ba. Write an equation for the reaction of magnesium with steam and an equation for the reaction of strontium with water.

Trend .....

Equation for magnesium .....

Equation for strontium.....

(3 marks)

(d) Sulphates of the Group II elements from Be to Ba have different solubilities. Give the formula of the least soluble of these sulphates and state **one** use that depends upon the insolubility of this sulphate.

Formula .....

Use .....

(2 marks)

(e) A solution contains ions of a Group II element, **M**. When aqueous sodium hydroxide is added a white precipitate forms. This precipitate dissolves in an excess of aqueous sodium hydroxide. Identify **M** and write ionic equations for the two reactions.

Identity of **M** .....

Equation 1 .....

Equation 2 .....

(3 marks)

(f) With the exception of beryllium chloride, Group II chlorides are classed as ionic. Explain why beryllium chloride is different by considering how a beryllium ion would interact with a chloride ion.

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(3 marks)

16

TURN OVER FOR SECTION B

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SECTION B

Answer **both** the questions below in the space provided on pages 10 to 16 of this booklet.

5 (a) State the relative charge and relative mass of a proton, of a neutron and of an electron. In terms of particles, explain the relationship between two isotopes of the same element. Explain why these isotopes have identical chemical properties. *(7 marks)*

(b) Define the term *relative atomic mass*. An element exists as a mixture of three isotopes. Explain, in detail, how the relative atomic mass of this element can be calculated from data obtained from the mass spectrum of the element. *(7 marks)*

6 (a) Explain why certain elements in the Periodic Table are classified as p-block elements. Illustrate your answer with an example of a p-block element and give its electronic configuration. *(3 marks)*

(b) Explain the meaning of the term *periodicity* as applied to the properties of rows of elements in the Periodic Table. Describe and explain the trends in atomic radius, in electronegativity and in conductivity for the elements sodium to argon. *(13 marks)*

END OF QUESTIONS

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