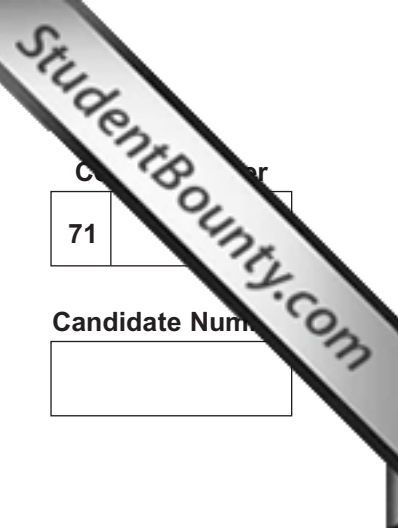




Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2011



Centre Number
71

Candidate Number

Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical
and Inorganic Chemistry

[AC111]



THURSDAY 13 JANUARY, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all sixteen** questions.

Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.

Answer **all six** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Quality of written communication will be assessed in question **14(d)**.

In Section A all questions carry equal marks, i.e. **two** marks for each question.

In Section B the figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

A Periodic Table of Elements (including some data) is provided.

For Examiner's use only	
Question Number	Marks
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	

Total Marks	
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Section A

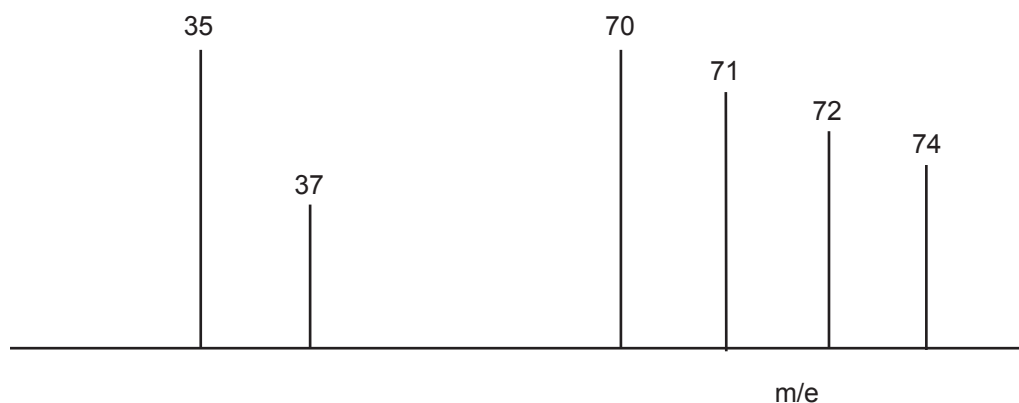
For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

- 1 An atom in which the number of protons is greater than the number of neutrons is
- A ${}^2\text{H}$.
 - B ${}^3\text{He}$.
 - C ${}^{10}\text{B}$.
 - D ${}^{39}\text{K}$.
- 2 Which one of the following is a correct description of electronic transitions in a given series in the atomic emission spectrum of hydrogen?
- A They all start from the ground state.
 - B They all end at the ground state.
 - C They all start from one particular energy level.
 - D They all end at one particular energy level.
- 3 Which one of the following lists the first ionisation energies (in kJ mol^{-1}) of the elements magnesium, aluminium, silicon, phosphorus and sulfur in this order?
- A 496 736 577 786 1060
 - B 577 786 1060 1000 1260
 - C 736 577 786 1060 1000
 - D 786 1060 1000 1260 1520

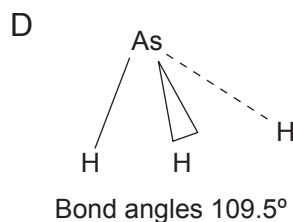
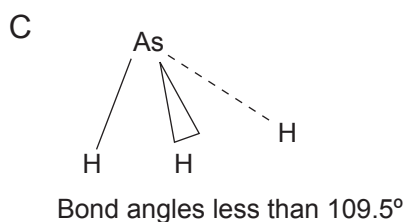
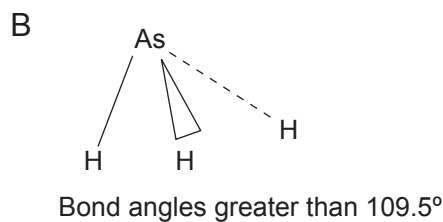
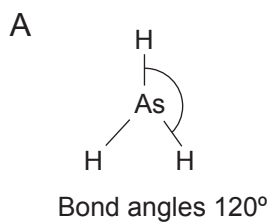
- 4 The mass spectrum of molecular chlorine, Cl_2 , is shown below. An additional peak is present in the spectrum which should not be present.

Which one of the following peaks should **not** be present?



- A 35
B 71
C 72
D 74
- 5 A solid melts sharply at $100\text{--}101^\circ\text{C}$. It does not conduct electricity even when molten. It dissolves in hydrocarbon solvents. The solid has
- A an atomic structure.
B a giant covalent structure.
C an ionic structure.
D a molecular covalent structure.
- 6 Which one of the following gaseous hydrides most readily decomposes into its elements on contact with a hot glass rod?
- A ammonia
B hydrogen fluoride
C hydrogen iodide
D steam

- 7 Arsine, AsH_3 , is a molecular hydride of arsenic which is found in Group V of the Periodic Table. Which one of the following is the structure of arsine in the vapour state?



- 8 50 cm^3 of 0.20 mol dm^{-3} sulphuric acid is exactly neutralised by

- A 100 cm^3 of 0.40 mol dm^{-3} potassium hydroxide solution.
 B 25 cm^3 of 0.20 mol dm^{-3} potassium hydroxide solution.
 C 50 cm^3 of 0.20 mol dm^{-3} potassium hydroxide solution.
 D 100 cm^3 of 0.20 mol dm^{-3} potassium hydroxide solution.

- 9 Which one of the following is the number of electrons which have approximately the same mass as that of a proton?

- A 20
 B 200
 C 2000
 D 20000

- 10 Which one of the following oxides is not polar?

- A CO
 B CO_2
 C H_2O
 D NO

Section B

Answer **all six** questions in this section.

- 11** Nitrogen dioxide, NO_2 , is one of the components of photochemical smog. The energy required to dissociate this molecule into NO molecules and O atoms is 305 kJ mol^{-1} . Use the following headings to calculate the frequency of radiation required to cause the dissociation.

(a) Convert 305 kJ into Joules

_____ [1]

(b) Calculate the number of Joules required to dissociate one molecule of nitrogen dioxide.

_____ [1]

(c) Use the equation $E = hf$ to convert the value in Joules into a frequency and state the units.

_____ [1]

12 The mineral beryl, $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$, is the principal source of beryllium. Although there are minerals richer in beryllium they are scarce and costly.

(a) Calculate the percentage, by mass, of beryllium in beryl.

[3]

(b) The metal beryllium is obtained either by the electrolysis of a fused mixture of beryllium and potassium chlorides at 350°C or by the reduction of beryllium fluoride with magnesium.

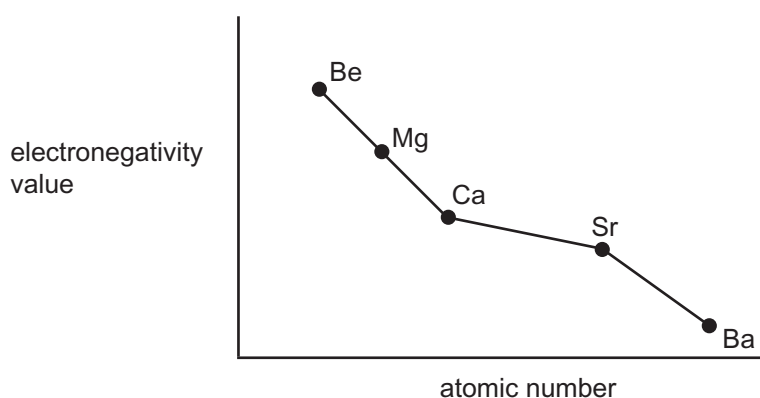
(i) Write an equation for the formation of beryllium from beryllium ions.

[1]

(ii) Write an equation for the formation of beryllium from the reduction of beryllium fluoride with magnesium.

[1]

(c) The first element in a Group often has more distinctive properties than the elements in the rest of the Group. This is often as a result of the difference in electronegativities. The electronegativity values of the Group II elements are shown below.



(i) Explain the meaning of the term **electronegativity**.

[2]

(ii) Using electronegativity suggest why beryllium chloride is a covalent molecule and barium chloride is ionic.

 _____ [2]

(iii) State **two** physical properties which could be used to distinguish these two chlorides.

 _____ [2]

(d) Beryllium chloride may be prepared by the action of chlorine or hydrogen chloride on the metal.

(i) Write the equation for the reaction of beryllium with hydrogen chloride.

_____ [1]

(ii) Draw a dot and cross diagram to show the formation of beryllium chloride from beryllium and chlorine atoms. Use only the outer electrons of each atom.

[3]

(iii) State the octet rule.

 _____ [2]

(iv) Beryllium chloride can be said to obey the octet rule and also not to obey the octet rule. Explain this contradiction.

 _____ [2]

(v) Draw the shape of a beryllium chloride molecule.

[1]

(vi) State the shape of the beryllium chloride molecule.

_____ [1]

(vii) Explain the shape of the beryllium chloride molecule.

_____ [2]

13 Chlorine forms a series of oxides some of which are listed below.

chlorine monoxide Cl_2O

chlorine dioxide ClO_2

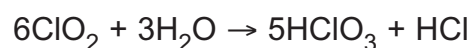
chlorine hexoxide Cl_2O_6

chlorine heptoxide Cl_2O_7

(a) Deduce the systematic name for chlorine heptoxide using the oxidation number of chlorine.

_____ [1]

(b) Chlorine dioxide dissolves in water to form a solution which eventually forms a mixture of chloric and hydrochloric acids.



The chlorine atoms in chlorine dioxide undergo disproportionation in this reaction.

(i) Explain the meaning of the term **disproportionation**.

_____ [1]

(ii) Calculate the oxidation number of chlorine in the reactant and in the products of this reaction and use them to confirm that the reaction is a disproportionation reaction.

_____ [3]

- 14 An experiment was set up to investigate the displacement reactions of the halogens.

Solutions of sodium halides were prepared and reacted with other halogens. The results table is shown below.

	sodium iodide (aq)	sodium bromide (aq)	sodium chloride (aq)
iodine solution		X	X
bromine solution	✓		
chlorine solution			

- ✓ means that a reaction took place
X means that no reaction took place

(a) Complete the **three** remaining places in the table. [2]

- (b) (i) Both bromine and iodine solutions are coloured. Describe the observations which would indicate that a reaction took place when aqueous sodium iodide is added to a bromine solution.

_____ [2]

- (ii) Write the ionic equation for the reaction between bromine solution and aqueous sodium iodide.

_____ [1]

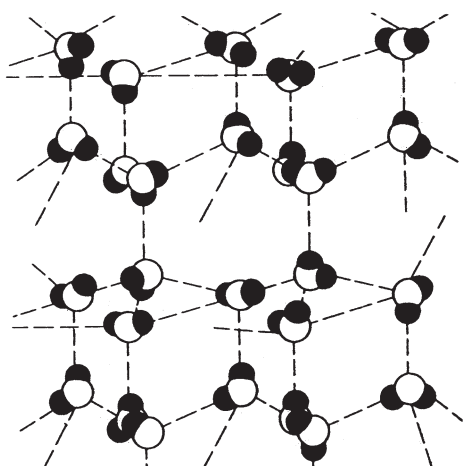
- (c) (i) Describe what is observed when chlorine solution is added to aqueous sodium bromide.

_____ [2]

- (ii) Write the equation for the reaction between chlorine solution and aqueous sodium bromide.

_____ [1]

15 The structure of ice is shown below. The water molecules are held together by hydrogen bonds which are a type of intermolecular force.



(a) Name **two** other types of intermolecular force.

_____ [2]

(b) (i) Explain how hydrogen bonding takes place between the water molecules in ice.

_____ [2]

(ii) Explain, using the structure above, why ice is less dense than water.

_____ [2]

(c) Although water is capable of forming hydrogen bonds it does not form long chains of “polywater” at room temperature. However, in the liquid state, molecules such as hydrogen fluoride do form very short chains. Suggest why water does not form chains and liquid hydrogen fluoride does.

_____ [2]

(d) Ammonia is another substance that can form hydrogen bonds. However, ammonia has a pyramidal structure.

(i) Draw two molecules of ammonia and show the hydrogen bond between the two molecules.

[2]

(ii) Explain why when ammonia reacts with a hydrogen ion it loses the ability to form hydrogen bonds.

[1]

(e) Explain why ammonia is extremely soluble in water.

[2]

- 16 Lithium exists in nature as two isotopes, ${}^6\text{Li}$ and ${}^7\text{Li}$. The composition of a sample of lithium in nature is shown in the table below.

isotope	% abundance
lithium 6	7.42
lithium 7	92.58

- (a) Draw the structure of a ${}^7\text{Li}$ atom, labelling all the sub-atomic particles.

[3]

- (b) State and explain to which of the s, p or d blocks lithium belongs.

_____ [2]

- (c) Calculate the relative atomic mass of lithium to two decimal places.

_____ [3]

(d) Lithium sulphate is readily soluble in water and crystallises from solution as the hydrate.

(i) Explain what is meant by the term **water of crystallisation**.

_____ [1]

(ii) Write the formula of anhydrous lithium sulphate.

_____ [1]

(iii) Calculate the formula of hydrated lithium sulphate if 3.76 g of the hydrated lithium salt produces 3.23 g of anhydrous lithium sulphate on heating.

_____ [3]

(e) Lithium sulphate can be used in a flame test. Explain how a flame test could be carried out and state the expected colour of the flame.

_____ [4]

THIS IS THE END OF THE QUESTION PAPER

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