Rewarding Learning

Centre Number	
71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2012

Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical and Inorganic Chemistry

[AC112]

AC112

FRIDAY 13 JANUARY, AFTERNOON

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 fifteen** 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 five** 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 **11**.
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	
Total Marks	

Section A

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

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

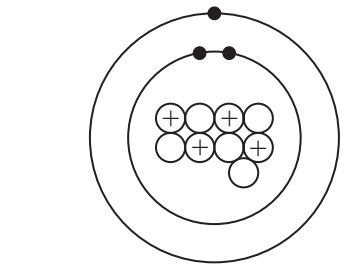
1 Which one of the following bonds is the most polar?

A B-F
B N-F
C C-I
D O-I

2 Which one of the following can **not** form hydrogen bonds?

A H_2O
B H_3O^+
C NH_3
D NH_4^+

3 Which one of the following is the name of the species shown below?



⊕ is a proton
◯ is a neutron
● is an electron

A beryllium atom
B beryllium ion
C lithium atom
D lithium ion

4 Which one of the following solids consists of molecular covalent crystals?

A Diamond
B Graphite
C Ice
D Quartz

5 When excess chlorine is bubbled into hot concentrated alkali which one of the following lists the main products of the reaction?

A Cl^-, ClO^-, H_2O
B Cl^-, ClO_3^-, H_2O
C Cl^-, ClO_4^-, H_2O
D ClO^-, ClO_3^-, H_2O

6 The elements X and Y are in Groups VI and VII respectively of the Periodic Table.

Which one of the following shows the formula and the bond type of the compound that they form?

A XY_2, covalent
B XY_2, ionic
C X_2Y, covalent
D X_2Y, ionic

7 Which one of the following orbitals is occupied by an electron with the energy level n = 2?

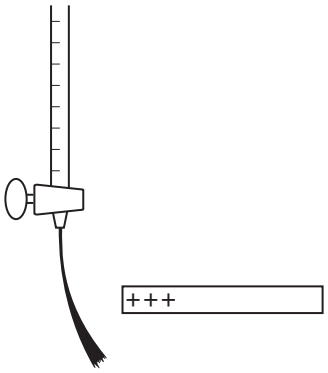
A A dumb-bell shaped orbital
B A spherically shaped orbital
C An s or d orbital
D An s or p orbital

8 A crystalline solid melts sharply at 95 °C. It does not conduct electricity in the solid or liquid states. It dissolves in hexane.

Which one of the following is the structure of the crystal?

A giant molecular
B ionic
C metallic
D molecular covalent

9 The diagram below shows a liquid escaping from a burette and passing a charged glass rod.



Which one of the following liquids will be attracted to the glass rod?

A CCl_4
B $CHCl_3$
C CS_2
D C_5H_{12}

10 The species Ar, K^+ and Ca^{2+} have the same number of electrons. Starting with the smallest, which one of the following is the order in which their radii increase?

A	Ar	Ca^{2+}	K^+
B	Ar	K^+	Ca^{2+}
C	Ca^{2+}	K^+	Ar
D	K^+	Ar	Ca^{2+}

Section B

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

11 The geometry of covalent inorganic hydrides may be predicted using the electron structures of the molecules.

Draw the shapes of the following hydrides using their outer electron structures. Explain these shapes giving the values of the angles between bonds.

hydrogen chloride	HCl
methane	CH_4
hydrogen sulfide	H_2S
ammonia	NH_3

[6]

Quality of written communication [2]

12 Solutions of acidified iodide ions are very easily oxidised to produce iodine molecules.
Even oxygen, from the air, will oxidise iodide ions to liberate iodine.
The following half-equations represent the formation of iodine molecules and the conversion of oxygen to water.

Equation 1 $2I^- \rightarrow I_2 + 2e^-$

Equation 2 $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

(a) (i) Using electron transfer explain which equation represents an oxidation reaction.

_____ [1]

(ii) Using electron transfer explain which equation represents a reduction reaction.

_____ [1]

(b) Write the equation for the reaction of acidified iodide ions with oxygen.

_____ [2]

(c) The following solutions were added to a solution of acidified iodide ions in separate test tubes.

chlorine, iron(III) ions, ammonia, sodium hydroxide, sodium chloride.

Which **two** of these solutions would react with acidified iodide ions to produce iodine?

_____ [2]

(d) The reaction of oxidising agents with potassium iodide can be used to prepare iodine in the laboratory. When heated with manganese dioxide and concentrated sulfuric acid, potassium iodide liberates iodine.

$$2KI + MnO_2 + 3H_2SO_4 \rightarrow 2KHSO_4 + MnSO_4 + 2H_2O + I_2$$

(i) Using oxidation numbers, explain this redox reaction.

_____

_____

_____ [3]

(ii) What observation would confirm that iodine had been produced?

_____ [1]

13 Phosphorus, P, reacts with bromine at room temperature to form phosphorus tribromide, PBr_3, which is a liquid with boiling point 173 °C. It reacts with water immediately forming hydrogen bromide and phosphoric(III) acid, H_3PO_3. The reaction is used as a method of preparing hydrogen bromide in the laboratory.

(a) Write the equation for the reaction of bromine with phosphorus.

_____ [1]

(b) Calculate the maximum mass of phosphorus tribromide which can be formed when 6.2 g of phosphorus, *which is an excess*, reacts with 8.0 cm^3 of bromine, Br_2. The density of liquid bromine is 3.1 g cm^{-3}.

mass of bromine, Br_2, in grams

_____ [1]

moles of bromine, Br_2

_____ [1]

moles of phosphorus, P, in 6.2 g

_____ [1]

moles of bromine, Br_2 reacting

_____ [1]

moles of phosphorus tribromide formed

_____ [1]

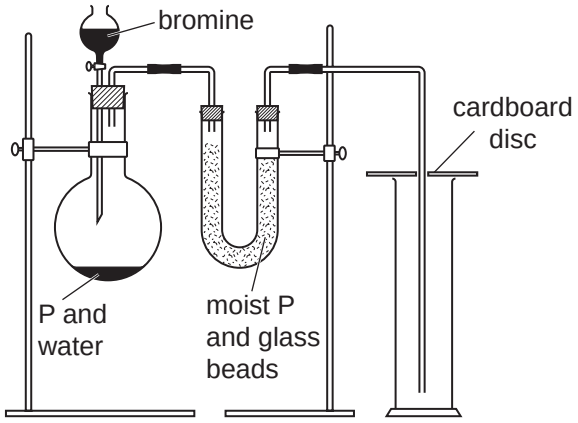
mass of phosphorus tribromide formed

_____ [1]

(c) Write the equation for the reaction of phosphorus tribromide with water.

_____ [1]

(d) The apparatus shown below was used to prepare hydrogen bromide in the laboratory. Bromine is slowly added to a paste of phosphorus and water. Phosphorus tribromide is first formed and is immediately decomposed by the water present. The gases produced are passed through a U-tube containing glass beads coated in phosphorus.



(i) Suggest why the bromine is not added all at once.

_____ [1]

(ii) An excess of water is not used in the experiment. What is the property of hydrogen bromide which is the reason for not using an excess?

_____ [1]

(iii) Why is the hydrogen bromide collected as shown and not with the delivery tube pointing upwards?

_____ [1]

(e) Hydrogen bromide is a colourless gas but produces fumes in moist air. Why does it fume in moist air?

_____ [1]

(f) When hydrogen bromide is heated in a loosely corked test tube it produces a very pale red–brown colour after heating for several minutes.

(i) Name the substance responsible for the red–brown colour.

_____ [1]

(ii) Explain what would be observed if a test tube of hydrogen iodide was heated.

_____ [1]

(iii) Explain what would be observed if a test tube of hydrogen chloride was heated.

_____ [1]

(iv) What do these observations indicate about the relative thermal stability of the hydrogen halides?

_____

_____ [1]

14 Only 0.08% of the Earth's crust consists of carbon yet this element is an essential part of living organisms. It occurs naturally as the isotopes carbon-12 and carbon-13 although there is a radioactive isotope carbon-14. Carbon occurs in nature as two structures known as diamond and graphite.

(a) Naturally occurring carbon contains 98.89% of carbon-12 and 1.11% carbon-13. Calculate the relative atomic mass of carbon to three decimal places.

_____

_____

_____ [3]

(b) Carbon-14 is not used in the calculation of the relative atomic mass because virtually none of it exists. It decomposes when a neutron in its nucleus changes into an electron and a proton forming a new element.

(i) What are the numbers of electrons, protons and neutrons in the new element?

_____ [2]

(ii) Name the element produced when carbon-14 decomposes.

_____ [1]

(c) Mass spectrometry uses carbon-12 as the international standard.

(i) What is the purpose of mass spectrometry?

_____

_____ [2]

(ii) Explain the meaning of the term **carbon-12 standard**.

_____

_____ [2]

(d) Explain why carbon-12 and carbon-14 are isotopes.

_____

_____ [2]

(e) Carbon may be produced in the laboratory in many ways. One is to heat cane sugar, $C_{12}H_{22}O_{11}$, with concentrated sulfuric acid. Steam and carbon are produced together with diluted sulfuric acid.

(i) Write the equation for the reaction. Do not include sulfuric acid in the equation.

_____ [1]

(ii) Explain the meaning of the terms **hydrated** and **water of crystallisation**.

_____

_____

_____

_____ [2]

(iii) Explain whether the cane sugar is hydrated.

_____

_____ [1]

(f) Diamond is oxidised when it burns in oxygen at about 700 °C.

(i) Name the product formed from the complete oxidation of diamond.

_____ [1]

(ii) Name the product formed from the incomplete oxidation of diamond.

_____ [1]

(iii) Explain whether graphite will form the same products when it is burned.

_____

_____ [2]

(g) Draw dot and cross diagrams, using outer electrons only, to show the formation of a carbon dioxide molecule from a carbon atom and an oxygen molecule.

[3]

15 Anhydrous copper(II) chloride, $CuCl_2$, may be prepared by heating copper in chlorine gas. When prepared by dissolving copper(II) oxide in hydrochloric acid, copper(II) chloride crystallises with two molecules of water of crystallisation.

(a) Write the equation for the reaction of copper with chlorine.

_____ [1]

(b) Write the equation for the reaction of copper(II) oxide with hydrochloric acid.

_____ [1]

(c) Write the formula for hydrated copper(II) chloride.

_____ [1]

(d) The purity of the copper(II) oxide may be determined by the process of back titration. Explain, without calculations, how this process would be carried out.

_____

_____

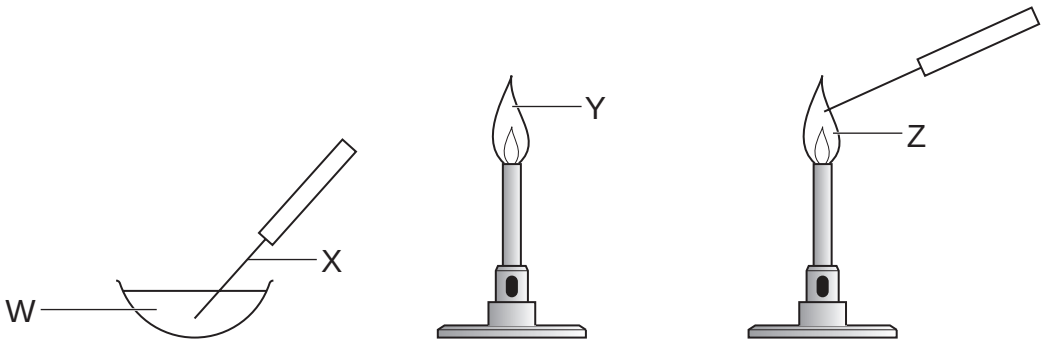
_____

_____

_____ [4]

(e) The presence of copper in copper(II) chloride can be shown using a flame test.

(i) The diagram below shows the equipment needed for the test. Identify the acid W, the metal wire X, the colour Y of the flame before the test and the colour Z during the test.



W _____ [1]

X _____ [1]

Y _____ [1]

Z _____ [1]

(ii) State **two** reasons for using W.

_____

_____

_____ [2]

(iii) Explain the origin of the flame colour produced by copper(II) chloride.

_____

_____

_____

_____ [3]

(f) When copper(II) chloride dissolves in water its ions are surrounded by water molecules. The polar water molecules surround both anion and cation.

(i) State the formulae of the ions present in copper(II) chloride.

_____ [2]

(ii) Draw a diagram showing two water molecules around the anion.

[1]

(iii) Draw a diagram showing two water molecules around the cation.

[1]

(iv) Explain how you would confirm the presence of chloride ions in the solution.

_____

_____

_____

_____ [3]

THIS IS THE END OF THE QUESTION PAPER

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