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RECOGNISING ACHIEVEMENT

Thursday 10 January 2013 – Morning

AS GCE CHEMISTRY A

F321/01 Atoms, Bonds and Groups

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour

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Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **12** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 Tungsten metal is used in the manufacture of some types of steel.

Tungsten has an atomic number of 74.

(a) Tungsten has many isotopes.

(i) Explain what is meant by *isotopes*.

.....

.....

..... **[1]**

(ii) The mass number of one isotope of tungsten is 184.

Complete the table below to show the atomic structure of this tungsten isotope.

Protons	Neutrons	Electrons

[1]

(iii) What is used as the standard measurement of relative isotopic mass?

..... **[1]**

(b) In the manufacture of tungsten metal, an oxide of tungsten, WO_3, is reacted with hydrogen gas.

$$WO_3(s) + 3H_2(g) \rightarrow W(s) + 3H_2O(g)$$

(i) Using **oxidation numbers**, show what has been oxidised and what has been reduced in this reaction.

oxidised .....

.....

reduced .....

..... **[2]**

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(ii) A chemist reacts 11.59 g of WO_3 with hydrogen gas.

Calculate the volume of hydrogen gas, in dm^3, required to completely react with this mass of WO_3 at room temperature and pressure.

volume of hydrogen gas = ... dm^3 **[3]**

[Total: 8]

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2 Simple molecules are covalently bonded.

(a) State what is meant by the term *covalent bond*.

.....

..... **[1]**

(b) Chemists are able to predict the shape of a simple covalent molecule from the number of electron pairs surrounding the central atom.

(i) Explain how this enables chemists to predict the shape.

.....

.....

.....

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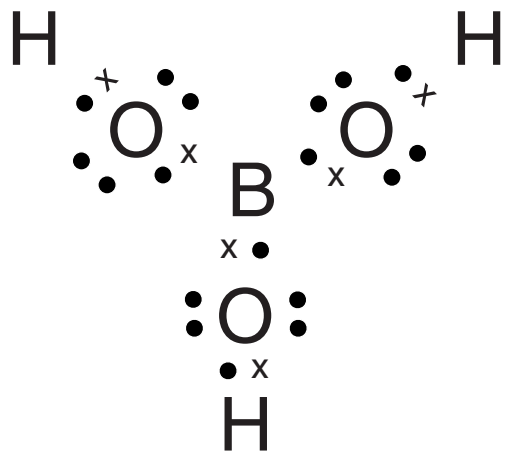
..... **[2]**

(ii) The '*dot-and-cross*' diagram of the simple covalent molecule, H_3BO_3, is shown below.



Predict the O–B–O and B–O–H bond angles in a molecule of H_3BO_3.

O–B–O = ... ° B–O–H = ... ° **[2]**

(c) Give an example of a simple covalent molecule which has all bond angles equal to 90°.

..... **[1]**

[Total: 6]

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3 Successive ionisation energies provide evidence for the existence of different shells in atoms.

(a) Define, in words, the term *first ionisation energy*.

.....

.....

.....

..... **[3]**

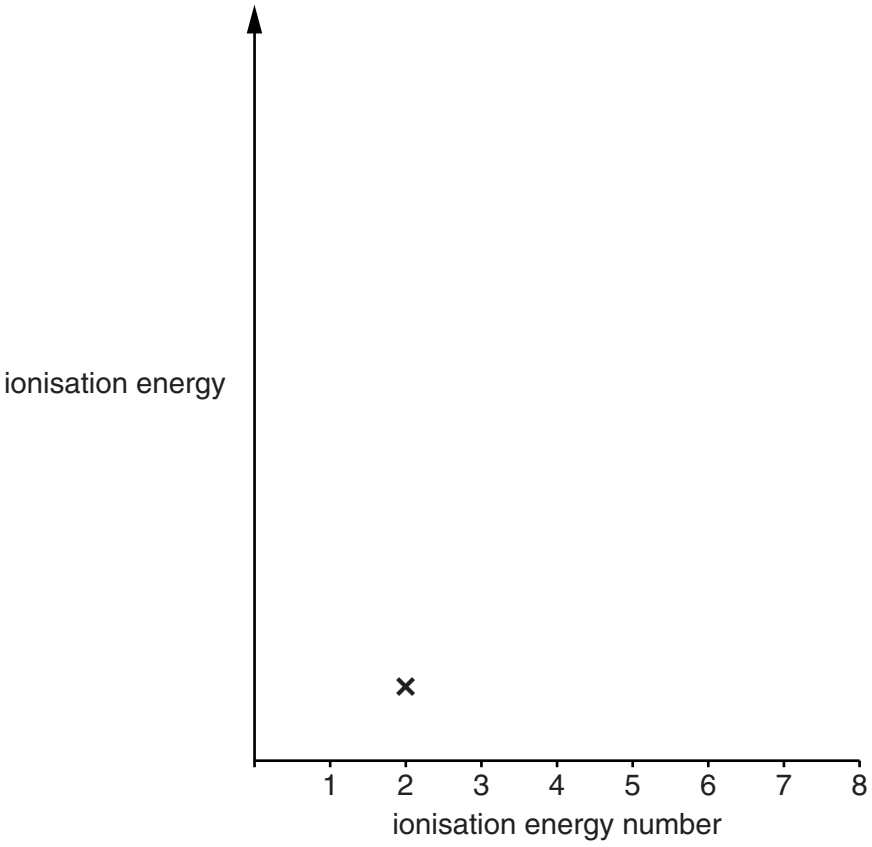
(b) **(i)** Write an equation to represent the **second** ionisation energy of oxygen.

Include state symbols.

..... **[1]**

(ii) On the axes below, add crosses to estimate the successive ionisation energies of oxygen. The second ionisation energy has been added for you.

It is **not** necessary to join your points.



[2]

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(c) The first ionisation energy of oxygen is **less** than the first ionisation energy of fluorine.

Explain why.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

(d) When oxygen reacts with metals it forms oxide ions.

Write the electron configurations, in terms of sub-shells, of an oxygen atom and an oxide ion.

Hence, explain why this reaction of oxygen is typical of a non-metal.

oxygen atom .....

oxide ion .....

.....

..... **[2]**

(e) Many ions contain oxygen combined with atoms of other elements.

For example, the nitrate(V) ion has the formula NO_3^-.

(i) In the table below, write the formula of the sulfate(IV) ion and the chlorate(III) ion.

Ion	Ionic charge	Formula
Nitrate(V)	1–	NO_3^-
Sulfate(IV)	2–	
Chlorate(III)	1–	

[2]

(ii) Write the formula of aluminium nitrate(V).

..... **[1]**

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(iii) Aluminium nitrate(V) can be made by reacting a base with an acid.

For this reaction, name a suitable base and write the formula of the acid.

name of base .....

formula of the acid ..... **[2]**

[Total: 16]

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4 The Group 2 element barium was first isolated by Sir Humphrey Davy in 1808.

Barium has a giant metallic structure and a melting point of 725 °C.

(a) Describe, with the aid of a labelled diagram, the structure and bonding in barium and explain why barium has a high melting point.

Include the correct charges on the metal particles in your diagram.

In your answer, you should use appropriate technical terms, spelled correctly.

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.....

.....

..... **[3]**

(b) A chemist reacts barium with water. A solution is formed which conducts electricity.

(i) Write the equation for the reaction of barium with water. Include state symbols.

..... **[2]**

(ii) Predict a value for the pH of the resulting solution.

..... **[1]**

(iii) Give the **formula** of the negative ion responsible for the conductivity of the solution formed.

..... **[1]**

(c) Heartburn is a form of indigestion caused by an excess of stomach acid.

State a compound of magnesium that could be used to treat heartburn.

..... **[1]**

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(d) In an experiment, a student makes a solution of strontium chloride, $SrCl_2$, by adding excess dilute hydrochloric acid to strontium carbonate.

(i) Describe what the student would observe and write the equation for the reaction.

observations .....

.....

equation ..... **[2]**

(ii) Draw a '*dot-and-cross*' diagram to show the bonding of strontium chloride.
Show **outer** electrons only.

[2]

(e) In another experiment, a student attempts to make a solution of strontium chloride by adding chlorine water to aqueous strontium bromide.

(i) Describe what the student would observe.

..... **[1]**

(ii) Write the ionic equation for the reaction which takes place.

..... **[1]**

(iii) Chlorine is more reactive than bromine. Explain why.

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..... **[4]**

[Total: 18]

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5 Hydrogen chloride is a colourless gas which forms white fumes in moist air.

(a) Molecules of hydrogen chloride, HC*l*, and molecules of fluorine, F_2, contain the same number of electrons. Hydrogen chloride boils at –85 °C and fluorine boils at –188 °C.

Explain why there is a difference in the boiling points of HC*l* and F_2.

In your answer you should refer to the types of force acting between molecules and the relative strength of the forces between the molecules.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

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.....

..... **[4]**

(b) Hydrogen chloride reacts with water to produce an ion with the formula H_3O^+.

An H_3O^+ ion has one dative covalent bond.

Draw a '*dot-and-cross*' diagram to show the bonding in H_3O^+.

Show **outer** electrons only.

[2]

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(c) Borax, $Na_2B_4O_7 \bullet 10H_2O$, can be used to determine the concentration of acids such as dilute hydrochloric acid.

A student prepares 250 cm^3 of a 0.0800 mol dm^{-3} solution of borax in water in a volumetric flask.

Calculate the mass of borax crystals, $Na_2B_4O_7 \bullet 10H_2O$, needed to make up 250 cm^3 of 0.0800 mol dm^{-3} solution.

answer = ... g **[3]**

Question 5 continues on page 12

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(d) The student found that 22.50 cm^3 of 0.0800 mol dm^{-3} $Na_2B_4O_7$ reacted with 25.00 cm^3 of dilute hydrochloric acid.

$$Na_2B_4O_7 + 2HCl + 5H_2O \rightarrow 2NaCl + 4H_3BO_3$$

(i) Calculate the amount, in mol, of $Na_2B_4O_7$ used.

amount = ... mol **[1]**

(ii) Calculate the amount, in mol, of HCl used.

amount = ... mol **[1]**

(iii) Calculate the concentration, in mol dm^{-3}, of the HCl.

concentration = ... mol dm^{-3} **[1]**

[Total: 12]

END OF QUESTION PAPER

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