OCR
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

*F3144201133*

*F 3 2 1 0 1*

| 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.

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]**

**(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]**

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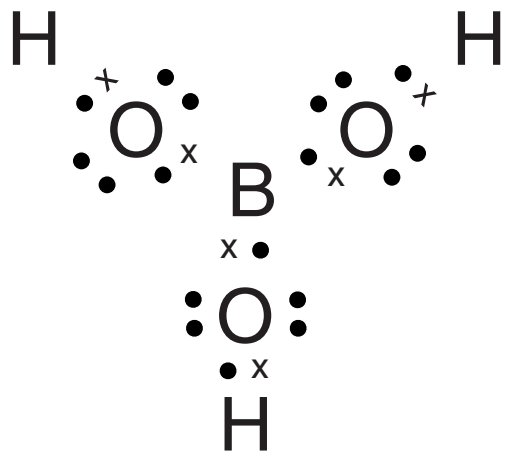
..... **[2]**

**(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]**

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

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

.....

.....

.....

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

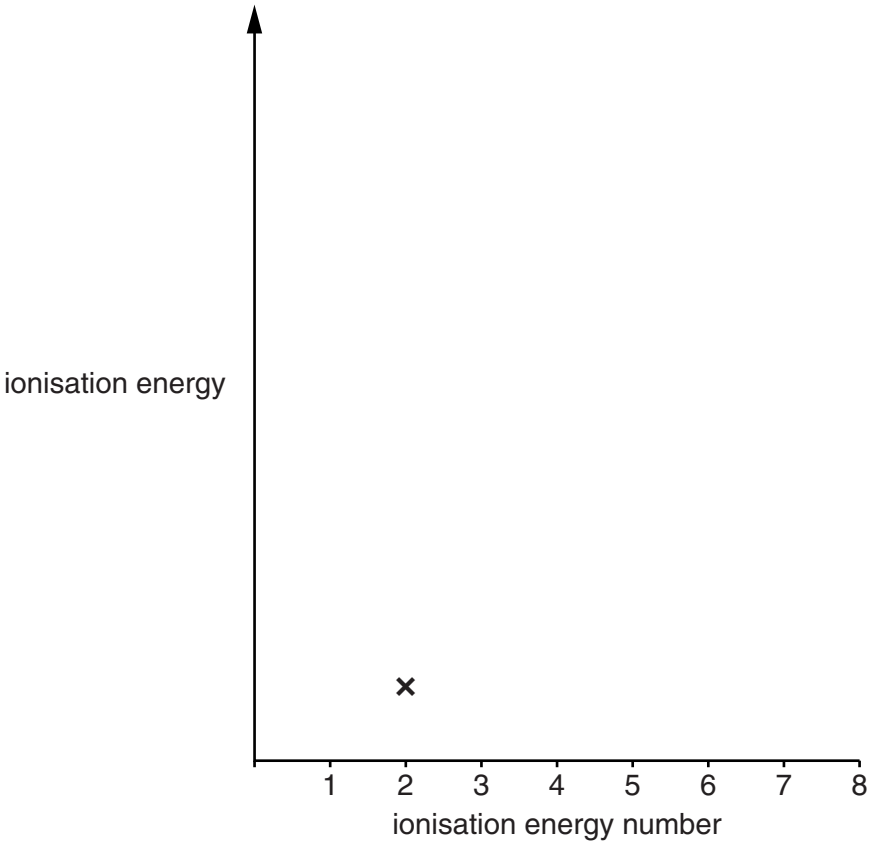
**(b)** **(i)** Write an equation to represent the **second** ionisation energy of oxygen.

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]**

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

Explain why.

.....

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.....

..... **[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]**

**(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]**

**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]**

**(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]**

**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]**

**(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**

**(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**