

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS  
AS GCE**

**F321/01**

**CHEMISTRY A**

**Atoms, Bonds and Groups**

**THURSDAY 10 JANUARY 2013: Morning**

**DURATION: 1 hour**

**plus your additional time allowance**

**MODIFIED ENLARGED 18pt**

<b>Candidate forename</b>		<b>Candidate surname</b>	
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<b>Centre number</b>						<b>Candidate number</b>				
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**Candidates answer on the Question Paper.**

**OCR SUPPLIED MATERIALS:**

**Data Sheet for Chemistry A (inserted)**

**OTHER MATERIALS REQUIRED:**


**Scientific calculator**

**READ INSTRUCTIONS OVERLEAF**

## **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 on the first page. 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).**

## **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.

**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.**

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

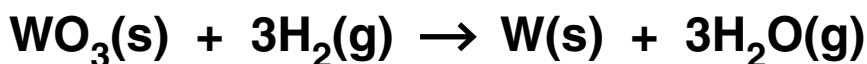
PROTONS	NEUTRONS	ELECTRONS

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

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**[1]**

- (b) In the manufacture of tungsten metal, an oxide of tungsten,  $\text{WO}_3$ , is reacted with hydrogen gas.



- (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  $\text{WO}_3$  with hydrogen gas.

Calculate the volume of hydrogen gas, in  $\text{dm}^3$ , required to completely react with this mass of  $\text{WO}_3$  at room temperature and pressure.

volume of hydrogen gas = \_\_\_\_\_  $\text{dm}^3$  [3]

[TOTAL: 8]

**2 Simple molecules are covalently bonded.**

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

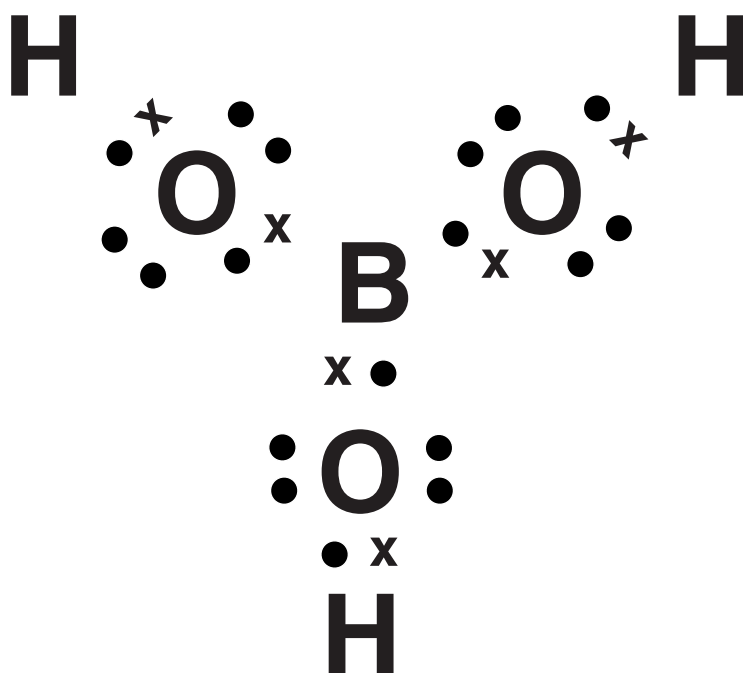
\_\_\_\_\_  
\_\_\_\_\_ [1]

**(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.**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

- (ii) The 'dot-and-cross' diagram of the simple covalent molecule,  $\text{H}_3\text{BO}_3$ , is shown below.



Predict the  $\text{O}-\text{B}-\text{O}$  and  $\text{B}-\text{O}-\text{H}$  bond angles in a molecule of  $\text{H}_3\text{BO}_3$ .

$\text{O}-\text{B}-\text{O} =$  \_\_\_\_\_ $^{\circ}$

$\text{B}-\text{O}-\text{H} =$  \_\_\_\_\_ $^{\circ}$  [2]

- (c) Give an example of a simple covalent molecule which has all bond angles equal to  $90^{\circ}$ .

\_\_\_\_\_ [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.**

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**[3]**

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

**Include state symbols.**

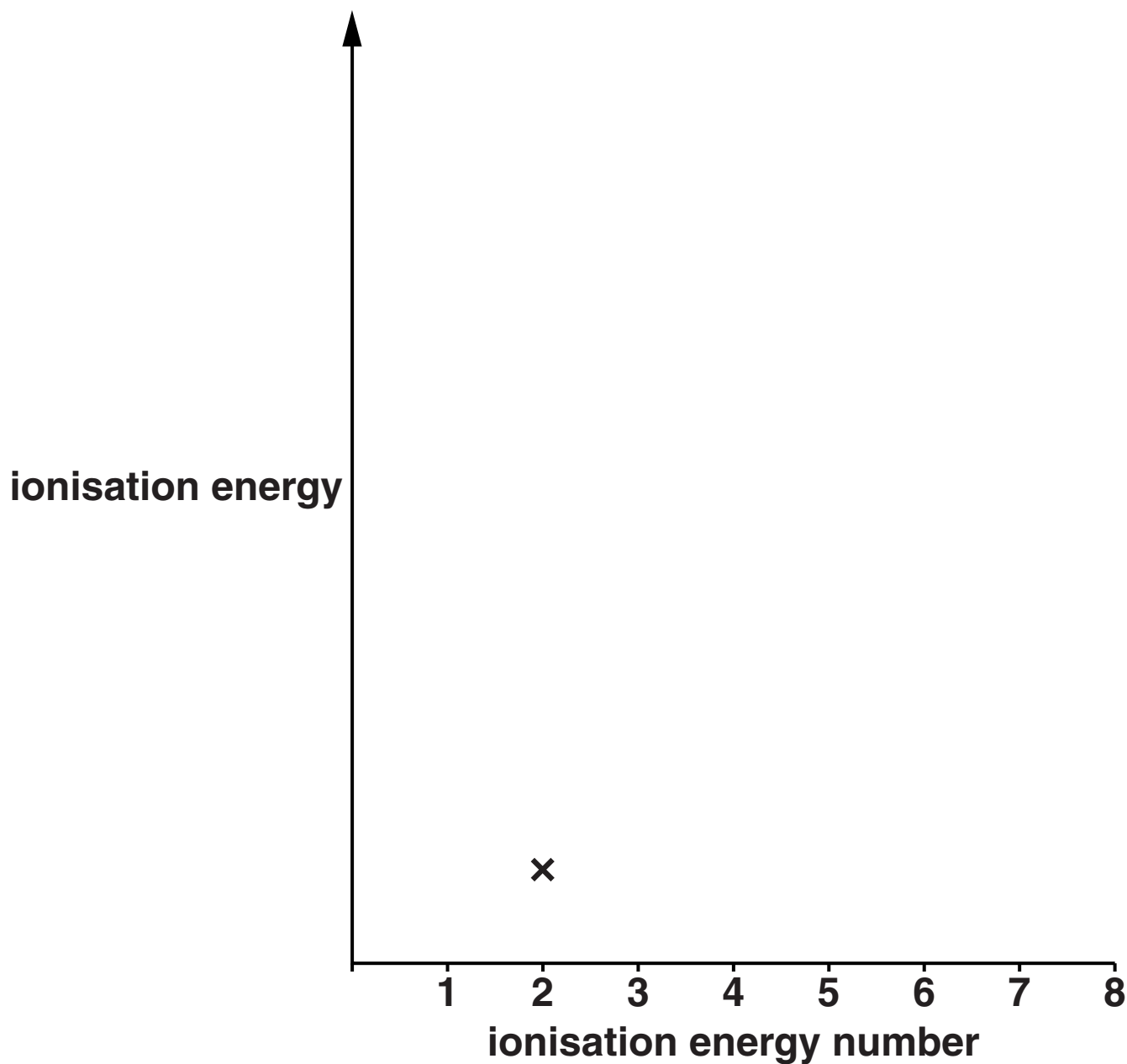
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**[1]**



- (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** \_\_\_\_\_

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[2]

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

For example, the nitrate(V) ion has the formula  $\text{NO}_3^-$ .

- (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–	$\text{NO}_3^-$
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,  $\text{SrCl}_2$ , 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.**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ **[4]**

**[TOTAL: 18]**

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

**(a) Molecules of hydrogen chloride,  $\text{HCl}$ , and molecules of fluorine,  $\text{F}_2$ , contain the same number of electrons. Hydrogen chloride boils at  $-85^\circ\text{C}$  and fluorine boils at  $-188^\circ\text{C}$ .**

**Explain why there is a difference in the boiling points of  $\text{HCl}$  and  $\text{F}_2$ .**

**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  $\text{H}_3\text{O}^+$ .**

**An  $\text{H}_3\text{O}^+$  ion has one dative covalent bond.**

**Draw a 'dot-and-cross' diagram to show the bonding in  $\text{H}_3\text{O}^+$ .**

**Show OUTER electrons only.**

**[2]**

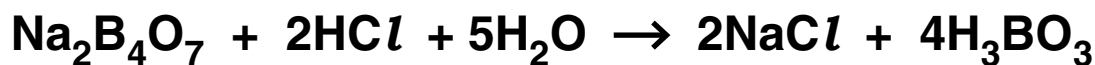
(c) Borax,  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ , can be used to determine the concentration of acids such as dilute hydrochloric acid.

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

Calculate the mass of borax crystals,  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ , needed to make up  $250\text{ cm}^3$  of  $0.0800\text{ mol dm}^{-3}$  solution.

answer = \_\_\_\_\_ g [3]

- (d) The student found that  $22.50 \text{ cm}^3$  of  $0.0800 \text{ mol dm}^{-3} \text{ Na}_2\text{B}_4\text{O}_7$  reacted with  $25.00 \text{ cm}^3$  of dilute hydrochloric acid.



- (i) Calculate the amount, in mol, of  $\text{Na}_2\text{B}_4\text{O}_7$  used.

amount = \_\_\_\_\_ mol [1]

- (ii) Calculate the amount, in mol, of  $\text{HCl}$  used.

amount = \_\_\_\_\_ mol [1]

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

concentration = \_\_\_\_\_  $\text{mol dm}^{-3}$  [1]

[TOTAL: 12]

END OF QUESTION PAPER

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