



**ADVANCED SUBSIDIARY GCE  
CHEMISTRY**

Foundation Chemistry

**WEDNESDAY 6 JUNE 2007**

**2811/01**

Morning

Time: 1 hour

Additional materials: Scientific calculator  
*Data Sheet for Chemistry* (Inserted)



Candidate  
Name

Centre  
Number

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Candidate  
Number

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**INSTRUCTIONS TO CANDIDATES**

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

**INFORMATION FOR CANDIDATES**

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.

**FOR EXAMINER'S USE**

Qu.	Max.	Mark
1	14	
2	10	
3	12	
4	16	
5	8	
<b>TOTAL</b>	<b>60</b>	

This document consists of **12** printed pages and a *Data Sheet for Chemistry*.



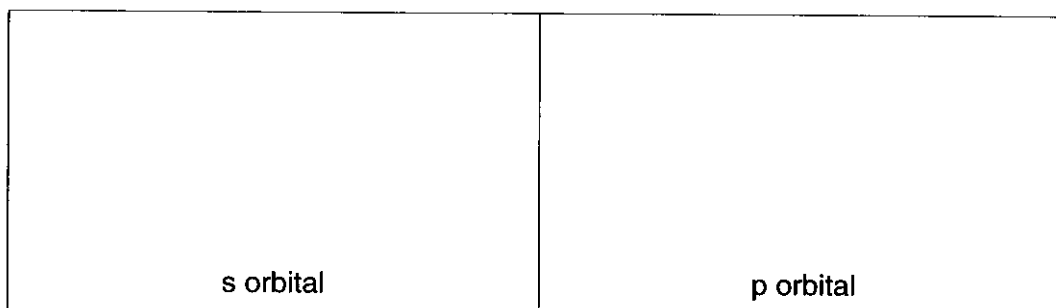
2

Answer **all** the questions.

1 Electrons are arranged in energy levels.

(a) An orbital is a region in which an electron may be found.

Draw diagrams to show the shape of an s orbital and of a p orbital.



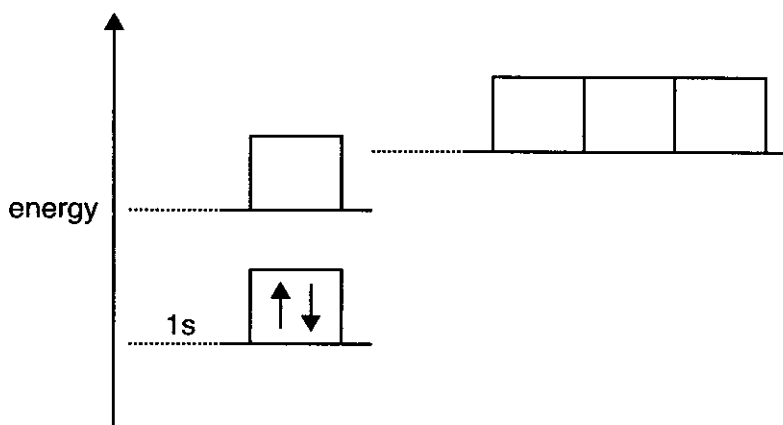
[2]

(b) Complete the table below to show how many electrons **completely** fill each of the following.

	number of electrons
a d orbital	
a p sub-shell	
the third shell ( $n = 3$ )	

[3]

(c) The energy diagram below is for the eight electrons in an oxygen atom. The diagram is incomplete as it only shows the two electrons in the 1s level.



Complete the diagram for the oxygen atom by:

(i) adding labels for the other sub-shell levels,

[1]

(ii) adding arrows to show how the other electrons are arranged.

[1]



- (d) Successive ionisation energies provide evidence for the arrangement of electrons in atoms. **Table 1.1** shows the eight successive ionisation energies of oxygen.

**Table 1.1**

ionisation number	1st	2nd	3rd	4th	5th	6th	7th	8th
ionisation energy /kJ mol <sup>-1</sup>	1314	3388	5301	7469	10989	13327	71337	84080

- (i) Define the term *first ionisation energy*.

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

- (ii) Write an equation, with state symbols, to represent the **third** ionisation energy of oxygen.

..... [2]

- (iii) Explain how the information in **Table 1.1** provides evidence for two electron shells in oxygen.

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

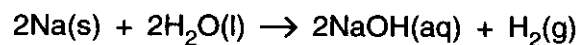
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4

2 This question looks at the reaction of sodium with water and with oxygen.

(a) A chemist reacted 0.0500 mol of sodium with water to form 50.0 cm<sup>3</sup> of aqueous sodium hydroxide.



(i) What mass of Na was reacted?

mass = ..... g [1]

(ii) Calculate the volume of H<sub>2</sub>, in dm<sup>3</sup>, that would be produced at room temperature and pressure, r.t.p.

1 mol of gas molecules occupies 24.0 dm<sup>3</sup> at r.t.p.

volume = ..... dm<sup>3</sup> [2]

(iii) Calculate the concentration, in mol dm<sup>-3</sup>, of NaOH that was formed.

concentration = ..... mol dm<sup>-3</sup> [1]

(b) Sodium reacts with oxygen to form sodium oxide, Na<sub>2</sub>O.

Draw a 'dot-and-cross' diagram for Na<sub>2</sub>O. Show outer electrons only.

[2]



(c) Sodium reacts with excess oxygen to form sodium peroxide,  $\text{Na}_2\text{O}_2$ .

$\text{Na}_2\text{O}_2$  is used in laundry bleaches. When added to water a reaction takes place forming an alkaline solution and hydrogen peroxide,  $\text{H}_2\text{O}_2$ .

(i) Construct a balanced equation for the formation of sodium peroxide from sodium.

..... [1]

(ii) Construct a balanced equation for the reaction of sodium peroxide with water.

..... [1]

(iii) Draw a 'dot-and-cross' diagram for a molecule of  $\text{H}_2\text{O}_2$ . Show outer electrons only.

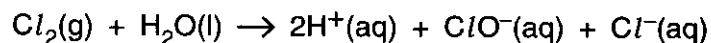
[2]

[Total: 10]



3 Chlorine is used in the production of safe drinking water throughout the world.

Drinking water is purified by addition of small amounts of chlorine. The reaction that takes place can be represented by the equation below.



(a) Describe a simple test that would confirm the presence of chloride ions in drinking water.

Include an equation in your answer.

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

(b) Chlorine can also be converted into bleach.

How is bleach made from chlorine? Include an equation in your answer.

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

(c) At room temperature and pressure, r.t.p., chlorine is a gas, bromine is a liquid and iodine is a solid.

Explain why these halogens have different physical states at r.t.p.

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



(d) In water treatment plants, care must be taken as chlorine can react with nitrogen compounds to form the highly explosive compound, nitrogen trichloride,  $\text{NCl}_3$ . Molecules of  $\text{NCl}_3$  have a bond angle of  $107^\circ$ .

(i) Name the shape of an  $\text{NCl}_3$  molecule.

..... [1]

(ii) Explain why a molecule of  $\text{NCl}_3$  has this shape and a bond angle of  $107^\circ$ .

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

[Total: 12]



- 4 Barium, Ba, was discovered by Davy in 1808. The element gets its name from the Greek 'barys' meaning 'heavy'.

(a) The table below compares some properties of barium with caesium.

element	Cs	Ba
group	1	2
atomic number	55	56
atomic radius/pm	531	435

- (i) Why do caesium and barium have different atomic numbers?

..... [1]

- (ii) State the block in the Periodic Table in which caesium and barium are found.

..... [1]

- (iii) Explain why the atomic radius of barium is **less** than the atomic radius of caesium.

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

- (iv) Predict and explain whether a barium **ion** is *larger*, *smaller* or the *same size* as a barium **atom**.

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





(b) Barium reacts with water in a redox reaction.



(i) Explain, in terms of electrons, what is meant by oxidation.

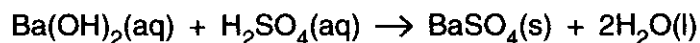
..... [1]

(ii) Which element has been oxidised in this reaction? Deduce the change in its oxidation number.

element .....

oxidation number changes from ..... to..... [2]

(iii) Sulphuric acid was added to aqueous barium hydroxide until the solution was just neutralised, forming the insoluble salt,  $\text{BaSO}_4$ , and water.

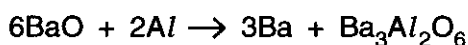


The electrical conductivity of the solution steadily decreased as the sulphuric acid was added.

Explain why the electrical conductivity decreased.

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

(c) Barium metal can be extracted from barium oxide,  $\text{BaO}$ , by reduction with aluminium.



Calculate the mass of barium metal that could be produced from reduction of 500 g of barium oxide using this method.

answer = ..... g [4]

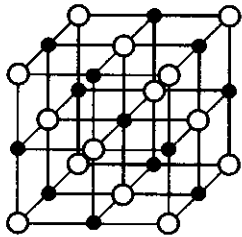
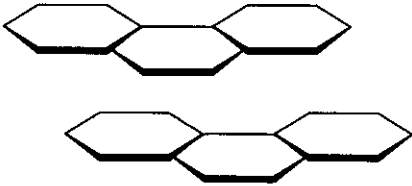
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10

- 5 In this question, one mark is available for the quality of spelling, punctuation and grammar.

Many physical properties can be explained in terms of bonding and structure. The table below shows the structures and some properties of sodium chloride and graphite in the solid state.

substance	sodium chloride	graphite
structure		
electrical conductivity of solid	poor	good
melting and boiling point	high	high
solubility in water	good	insoluble

Explain these properties in terms of bonding and structure.

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