

**ADVANCED SUBSIDIARY GCE  
CHEMISTRY**

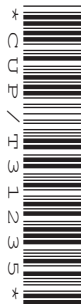
Foundation Chemistry

**THURSDAY 10 JANUARY 2008**

**2811/01**

Morning  
Time: 1 hour

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



Candidate  
Forename

Candidate  
Surname

Centre  
Number

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Candidate  
Number

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**INSTRUCTIONS TO CANDIDATES**

- Write your name in capital letters, your 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 that you know what you have to do before starting your answer.
- Do **not** write in the bar codes.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

**INFORMATION FOR CANDIDATES**

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **60**.
- 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	15	
2	19	
3	15	
4	11	
<b>TOTAL</b>	<b>60</b>	

This document consists of **10** printed pages, **2** blank pages and a *Data Sheet for Chemistry*.

Answer **all** the questions.

- 1** A sample of the element boron, B, was analysed using a mass spectrometer and was found to contain two isotopes,  $^{10}\text{B}$  and  $^{11}\text{B}$ .

**(a) (i)** Explain the term *isotopes*.

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

**(ii)** Complete the table below for the two isotopes of boron.

isotope	protons	neutrons	electrons
$^{10}\text{B}$			
$^{11}\text{B}$			

[2]

**(b)** The relative atomic mass of boron in the sample analysed was 10.8.

**(i)** Define the term *relative atomic mass*.

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

**(ii)** What does the value for the relative atomic mass suggest about the relative proportions of the boron isotopes in the sample?

Explain your reasoning.

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

(c) The element boron was first isolated in 1808 by reacting boric acid,  $\text{H}_3\text{BO}_3$ , with potassium.

(i) In addition to boron, the reaction produces an alkali.

Suggest a balanced equation for this reaction.

.....[1]

(ii) Explain, using oxidation numbers, why boron in boric acid has been reduced.

.....

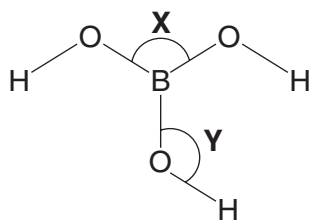
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.....[2]

(d) The structure of a molecule of boric acid is shown below.

Predict values for the bond angles labelled **X** and **Y** in a boric acid molecule.

Explain your reasoning.



bond angle **X**.....

reasoning.....

.....

.....

bond angle **Y**.....

reasoning.....

.....

.....[5]

[Total: 15]

- 2** Quicklime,  $\text{CaO}$ , and slaked lime,  $\text{Ca(OH)}_2$ , are bases made by the chemical industry with uses in building and farming.

**(a) (i)** How is quicklime made by the chemical industry?

.....[1]

**(ii)** Give one use of slaked lime in farming.

.....[1]

- (b)** Slaked lime is slightly soluble in water forming a solution commonly referred to as limewater. A student carried out a titration to find the concentration of limewater.  $25.0\text{cm}^3$  of limewater was neutralised by  $22.45\text{cm}^3$  of  $0.0105\text{mol dm}^{-3}$  nitric acid,  $\text{HNO}_3$ .

**(i)** Balance the equation for the reaction that takes place.



**(ii)** Calculate how many moles of  $\text{HNO}_3$  were used.

..... mol [1]

**(iii)** Determine how many moles of  $\text{Ca(OH)}_2$  reacted with the  $\text{HNO}_3$ .

..... mol [1]

**(iv)** Calculate the concentration, in  $\text{mol dm}^{-3}$ , of the  $\text{Ca(OH)}_2$  in the limewater.

.....  $\text{mol dm}^{-3}$  [1]

**(v)** After the titration, the student allowed the water to evaporate to obtain a hydrated crystalline solid with a molar mass of  $272.1\text{ g mol}^{-1}$ .

Determine the formula of the hydrated solid. Show your working.

[2]

- (c) Limewater can be made by adding calcium metal to water.

Write an equation, with state symbols, for this reaction.

.....[2]

- (d) When calcium metal reacts, each calcium atom loses two electrons. The energy change required to convert Ca atoms into  $\text{Ca}^{2+}$  ions involves both first and second ionisation energies. The first and second ionisation energies of calcium are shown below.

ionisation number	1st	2nd
ionisation energy / $\text{kJ mol}^{-1}$	578	1145

- (i) Write an equation, including state symbols, that represents the second ionisation energy of calcium.

.....[2]

- (ii) Calculate how much energy, in kJ, would be needed to form 5.00g of  $\text{Ca}^{2+}(\text{g})$  ions from  $\text{Ca}(\text{g})$ .

Give your answer to three significant figures.

answer = ..... kJ [3]

- (iii) The first ionisation energies of the elements in Group 2 show a trend.

State and explain this trend.

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

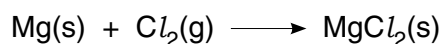
[Total: 19]

**3** This question is about the chemistry of chlorine and its compounds.

**(a)** Complete the electronic configuration of an atom of  $Cl$ .

$1s^2$  .....[1]

**(b)** Chlorine reacts with magnesium to form magnesium chloride.



**(i)** Draw a 'dot-and-cross' diagram for  $MgCl_2$ .

[2]

**(ii)** Solid  $MgCl_2$  does not conduct electricity but solid magnesium does.

Solid  $MgCl_2$  dissolves in water and the resulting solution does conduct electricity.

Explain these observations.

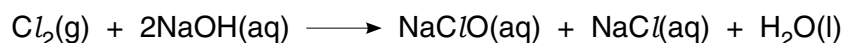
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 .....  
 .....  
 .....[3]

**(c)** Chlorine and magnesium are both elements in Period 3 of the Periodic Table. The radius of a  $Cl$  atom is smaller than that of an atom of  $Mg$ .

Explain why.

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

- (d) Bleach is a solution of sodium chlorate(I),  $\text{NaClO}$ , made by reacting chlorine with aqueous sodium hydroxide.



A student prepared some bleach by reacting  $145\text{ cm}^3$  of chlorine gas with an aqueous solution containing  $0.0100\text{ mol NaOH}$ .

Under these conditions,  $1.00\text{ mol}$  of  $\text{Cl}_2(\text{g})$  has a volume of  $24.0\text{ dm}^3$ .

Determine whether  $\text{Cl}_2$  or  $\text{NaOH}$  was in excess of its reacting quantity.

Show all your working.

[2]

- (e) You are supplied with two solutions:  $\text{NaCl}(\text{aq})$  and  $\text{NaBr}(\text{aq})$ .

Outline how you could distinguish between these two solutions using simple experiments. Include relevant equations.

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 15]

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

Water, methane and hydrogen chloride all have simple molecular structures but differ in their intermolecular forces.

**(a)** Describe, with the aid of a diagram, the hydrogen bonding in water.

State and explain **two** anomalous properties of water in terms of this bonding.

[7]



(b) The boiling points of methane and hydrogen chloride are shown in the table below.

substance	boiling point/°C
methane	−164
hydrogen chloride	−85

Explain why methane and hydrogen chloride have different boiling points.

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.....[3]

Quality of Written Communication [1]

[Total: 11]

**END OF QUESTION PAPER**

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