

**ADVANCED SUBSIDIARY GCE**  
**CHEMISTRY A**  
Atoms, Bonds and Groups

**F321**

Candidates answer on the question paper.

**OCR supplied materials:**

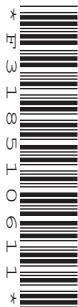
- *Data Sheet for Chemistry A* (inserted)

**Other materials required:**

- Scientific calculator

**Monday 23 May 2011**  
**Afternoon**

**Duration: 1 hour**




|                       |  |                      |  |
|-----------------------|--|----------------------|--|
| Candidate<br>forename |  | Candidate<br>surname |  |
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|               |  |  |  |  |  |  |                  |  |  |  |  |
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| Centre number |  |  |  |  |  |  | Candidate number |  |  |  |  |
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**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. Pencil may be used for graphs and diagrams only.
- 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. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Answer **all** the questions.
- 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 **16** pages. Any blank pages are indicated.

Answer **all** the questions.

1 This question is about a model of the structure of the atom.

- (a) A model used by chemists includes the relative charges, the relative masses and the distribution of the sub-atomic particles making up the atom.

Complete the table below.

| particle | relative charge | relative mass | position within the atom |
|----------|-----------------|---------------|--------------------------|
| proton   |                 |               |                          |
| neutron  |                 |               |                          |
| electron |                 | 1/2000        | shell                    |

[1]

- (b) Early studies of ionisation energies helped scientists to develop a model for the electron structure of the atom.

Define the term *first ionisation energy*.

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[3]

- (c) A modern model of the atom arranges electrons into orbitals, sub-shells and shells.

Complete the following table showing the maximum number of electrons which can be found within each region.

| region           | number of electrons |
|------------------|---------------------|
| a 2p orbital     |                     |
| the 3s sub-shell |                     |
| the 4th shell    |                     |

[3]

- (d) The modern Periodic Table arranges the elements in order of their atomic number. When arranged in this order the elements show periodicity.

Explain what is meant by the term *periodicity*.

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

- (e) In this part, you need to refer to the *Periodic Table of the Elements* in the *Data Sheet for Chemistry A*.

From the first 18 elements **only**, choose an element which fits the following descriptions.

- (i) An element with an isotope that can be represented as  $^{14}_6\text{X}$ . ..... [1]  
 (ii) The element which has the strongest metallic bonding in Period 3. .... [1]  
 (iii) The element which forms a 3- ion with the same electron structure as Ne. .... [1]  
 (iv) The element which has the smallest third ionisation energy. .... [1]  
 (v) The element with the first six successive ionisation energies shown below, in  $\text{kJ mol}^{-1}$ .

738      1451      7733      10541      13629      17995

..... [1]

[Total: 13]

- 2 Magnesium is the eighth most abundant element in the Earth's crust and many rocks are a source of magnesium compounds.

Magnesium carbonate,  $\text{MgCO}_3$ , is present in dolomite, a rock found in the Dolomite mountains in Italy.

A student collected two equal-sized samples of dolomite. These samples were put into two labelled test-tubes, **A** and **B**. Tube **A** was heated until there was no further change in mass and was then allowed to cool. Tube **B** was left unheated.

- (a) Write the equation for the action of heat on the magnesium carbonate present in tube **A**.

..... [1]

- (b) The student wanted to make magnesium chloride crystals. The student added an excess of warm dilute hydrochloric acid to tube **A** and to tube **B**.

- (i) Write the equation for the reaction of magnesium carbonate in tube **B** with dilute hydrochloric acid.

Include state symbols.

..... [2]

- (ii) State **one** similarity and **one** difference the student would see between the reactions in the two tubes.

similarity .....

.....

difference .....

..... [2]

- (iii) From the solution in each tube, the student obtained crystals with the formula  $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ .

Calculate the relative formula mass of  $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ .

Give your answer to **one** decimal place.

relative formula mass = ..... [1]

(iv) Draw a 'dot-and-cross' diagram to show the bonding in  $\text{MgCl}_2$ .

Show **outer** electrons only.

[2]

(c) A compound containing magnesium, silicon and oxygen is also present in rock types in Italy. A sample of this compound weighing 5.27 g was found to have the following composition by mass:

Mg, 1.82 g; Si, 1.05 g; O, 2.40 g.

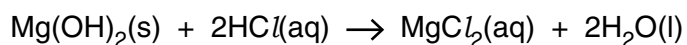
Calculate the empirical formula of the compound.

Show your working.

empirical formula = ..... [2]

- (d) Pharmacists sell tablets containing magnesium hydroxide,  $\text{Mg}(\text{OH})_2$ , to combat indigestion.

A student carried out an investigation to find the percentage by mass of  $\text{Mg}(\text{OH})_2$  in an indigestion tablet. The student reacted the tablet with dilute hydrochloric acid.



The student found that  $32.00 \text{ cm}^3$  of  $0.500 \text{ mol dm}^{-3} \text{ HCl}$  was needed to react with the  $\text{Mg}(\text{OH})_2$  in a 500 mg tablet. [1 g = 1000 mg].

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

amount = ..... mol [1]

- (ii) Determine the amount, in mol, of  $\text{Mg}(\text{OH})_2$  present in the tablet.

amount = ..... mol [1]

- (iii) Determine the percentage by mass of  $\text{Mg}(\text{OH})_2$  present in the tablet.

answer = ..... % [3]

[Total: 15]

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3 The chlor-alkali industry is an important part of the UK chemical industry.

The raw material is brine, a concentrated aqueous solution of sodium chloride,  $\text{NaCl}(\text{aq})$ . Two products that can be manufactured from brine are chlorine and sodium hydroxide — hence the name chlor-alkali.

(a) Bleach can be made by reacting chlorine with cold aqueous sodium hydroxide. A solution of bleach contains the chlorate compound  $\text{NaClO}$ .

Write the equation for the reaction taking place.

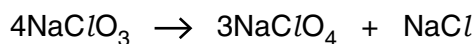
..... [1]

(b) The systematic name for  $\text{NaClO}$  is sodium chlorate(I). Other chlorate compounds exist, such as  $\text{NaClO}_3$ .

(i) Give the systematic name for  $\text{NaClO}_3$ .

..... [1]

(ii) When heated,  $\text{NaClO}_3$  disproportionates as shown in the equation below.



Using oxidation numbers, explain why this is a disproportionation reaction.

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



(c) Chlorine has been added to drinking water for over a century. Recently, some scientists have put forward the case for **not** chlorinating drinking water. This is because chlorine may react with organic compounds in the water to form  $\text{CH}_3\text{Cl}$ .

(i) State **one** valid reason that supports the scientists' case and state **one** reason why chlorine should be added to drinking water.

.....

.....

.....

..... [2]

(ii) Draw a 'dot-and-cross' diagram to show the bonding in a molecule of  $\text{CH}_3\text{Cl}$ .

Show **outer** electrons only.

[1]

(iii) Name the shape of a molecule of  $\text{CH}_3\text{Cl}$ .

..... [1]

(d) A sample of brine is a concentrated aqueous solution of sodium chloride,  $\text{NaCl}(\text{aq})$ .

Describe a simple chemical test that you could carry out to show that brine contains aqueous chloride ions. How would you confirm that no other halide ions are present?

Include an ionic equation in your answer.

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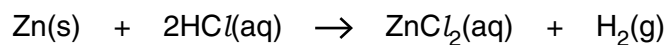
..... [4]

[Total: 13]

Turn over

4 Many metallic elements react with dilute hydrochloric acid to form a solution containing a salt.

(a) Zinc reacts with dilute hydrochloric acid to form a solution of the salt, zinc chloride,  $\text{ZnCl}_2$ .



(i) Explain why  $\text{ZnCl}_2$  is a salt.

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

(ii) Predict the formula of the zinc salt that could be formed by adding an excess of zinc to phosphoric(V) acid,  $\text{H}_3\text{PO}_4$ .

..... [1]



5 Solids exist as lattice structures.

(a) Giant metallic lattices conduct electricity. Giant ionic lattices do not. If a giant ionic lattice is melted, the molten ionic compound will conduct electricity.

Explain these observations in terms of bonding, structure and particles present.

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

(b) The solid lattice structure of ammonia,  $\text{NH}_3$ , contains hydrogen bonds.

(i) Draw a diagram to show hydrogen bonding between **two** molecules of  $\text{NH}_3$  in a solid lattice.

Include relevant dipoles and lone pairs.

[2]

(ii) Suggest why ice has a higher melting point than solid ammonia.

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





15  
ADDITIONAL PAGE

Dotted lines for writing.

