OCR
RECOGNISING ACHIEVEMENT

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

F3185101611

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. 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*.

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..... **[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 $^{14}_{6}X$. ..... **[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 $kJ\,mol^{-1}$.

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, $MgCO_3$, 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 $MgCl_2 \bullet 6H_2O$.

Calculate the relative formula mass of $MgCl_2 \bullet 6H_2O$.

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

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

(iv) Draw a *'dot-and-cross'* diagram to show the bonding in $MgCl_2$.

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, $Mg(OH)_2$, to combat indigestion.

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

$$Mg(OH)_2(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + 2H_2O(l)$$

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

(i) Calculate the amount, in mol, of HC*l* used.

amount = ... mol **[1]**

(ii) Determine the amount, in mol, of $Mg(OH)_2$ present in the tablet.

amount = ... mol **[1]**

(iii) Determine the percentage by mass of $Mg(OH)_2$ 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, NaC*l*(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 NaC*l*O.

Write the equation for the reaction taking place.

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

(b) The systematic name for NaC*l*O is sodium chlorate(I). Other chlorate compounds exist, such as $NaClO_3$.

(i) Give the systematic name for $NaClO_3$.

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

(ii) When heated, $NaClO_3$ disproportionates as shown in the equation below.

$$4NaClO_3 \longrightarrow 3NaClO_4 + NaCl$$

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 CH_3Cl.

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

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

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in a molecule of CH_3Cl.

Show **outer** electrons only.

[1]

(iii) Name the shape of a molecule of CH_3Cl .

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

(d) A sample of brine is a concentrated aqueous solution of sodium chloride, NaCl(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]

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, $ZnCl_2$.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

(i) Explain why $ZnCl_2$ is a salt.

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

(ii) Predict the formula of the zinc salt that could be formed by adding an excess of zinc to phosphoric(V) acid, H_3PO_4.

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

(b) Group 2 elements also react with dilute hydrochloric acid.

Describe **and** explain the trend in reactivity of the Group 2 elements with dilute hydrochloric acid as the group is descended.

In your answer you should use appropriate technical terms, spelled correctly.

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..... **[5]**

[Total: 7]

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

(b) The solid lattice structure of ammonia, NH_3, contains hydrogen bonds.

(i) Draw a diagram to show hydrogen bonding between **two** molecules of 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]**

(c) Solid SiO_2 melts at 2230 °C. Solid $SiCl_4$ melts at –70 °C. Neither of the liquids formed conducts electricity.

Suggest the type of lattice structure in solid SiO_2 and in solid $SiCl_4$ and explain the difference in melting points in terms of **bonding** and **structure**.

In your answer you should use appropriate technical terms, spelled correctly.

.... **[5]**

[Total: 12]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

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