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RECOGNISING ACHIEVEMENT

**ADVANCED SUBSIDIARY GCE**

# CHEMISTRY

Foundation Chemistry

**THURSDAY 11 JANUARY 2007**

**2811/01**

Morning

Time: 1 hour

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

Candidate Name

Centre Number

Candidate Number

**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 | 13 | |
| 2 | 15 | |
| 3 | 9 | |
| 4 | 7 | |
| 5 | 16 | |
| TOTAL | 60 | |

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


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*2470215011*

Answer **all** the questions.

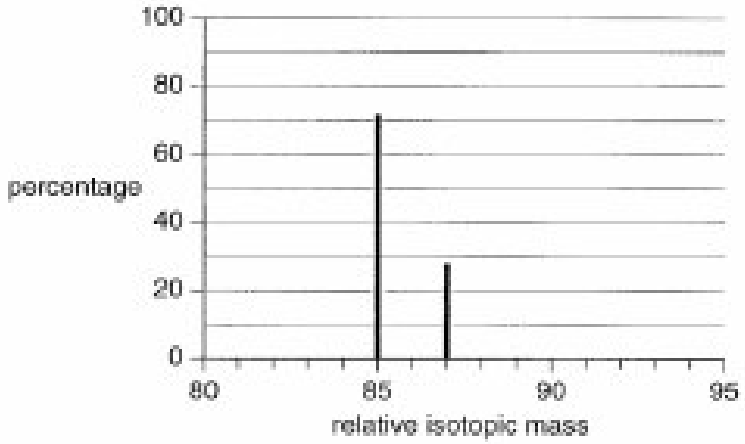
1 Rubidium, atomic number 37, was discovered in 1861 by Bunsen and Kirchoff. Rubidium is in Group 1 of the Periodic Table and the element has two natural isotopes, $^{85}Rb$ and $^{87}Rb$.

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

.....

.....[1]

**(b)** A sample of rubidium was analysed in a mass spectrometer to produce the mass spectrum below.




(i) Use this mass spectrum to help you complete the table below.

| isotope | percentage | number of | | |
|---|---|---|---|---|
| | | protons | neutrons | electrons |
| $^{85}Rb$ | | | | |
| $^{87}Rb$ | | | | |

[3]

(ii) Calculate the relative atomic mass of this rubidium sample.
Give your answer to three significant figures.

$A_r$ = .....[2]

**(c)** Which isotope is used as the standard against which the masses of the two rubidium isotopes are measured?

.....[1]

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**(d)** In a mass spectrometer, gaseous atoms are ionised.

Explain why less energy is needed to ionise gaseous atoms of rubidium than gaseous atoms of sodium.

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.....[3]

**(e)** Rubidium forms an ionic compound with silver and iodine. This compound has a potential use in miniaturised batteries because of its high electrical conductivity.

The empirical formula of this ionic compound can be calculated from its percentage composition by mass: Rb, 7.42%; Ag, 37.48%; I, 55.10%.

**(i)** Define the term *empirical formula*.

.....

.....

.....[1]

**(ii)** Calculate the empirical formula of the compound.

[2]

[Total: 13]

2 Solid calcium hydroxide, $Ca(OH)_2$, is commonly known as 'slaked lime'. Over one million tonnes of slaked lime are produced annually in the UK.

(a) Lime water is an aqueous solution of calcium hydroxide, $Ca(OH)_2$. Lime water is commonly used in the laboratory as a test for carbon dioxide.

(i) Suggest a value for the pH of lime water.

.....[1]

(ii) Write an equation, including state symbols, for the precipitation reaction that takes place in the lime water test for carbon dioxide.

.....[2]

(iii) When an **excess** of carbon dioxide is bubbled through lime water, a further reaction takes place.

State what you would see as this further reaction takes place and also state the formula of the product of the reaction.

observation.....

formula of product .....[2]

(b) The ions present in $Ca(OH)_2$ are $Ca^{2+}$ and $OH^-$.

(i) Complete the electronic configuration of a $Ca^{2+}$ ion.

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

(ii) How many moles of ions are in one mole of $Ca(OH)_2$?

moles of ions = .....[1]

(iii) How many moles of electrons are in one mole of $OH^-$ ions?

moles of electrons = .....[1]

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(iv) Draw a '*dot-and-cross*' diagram of $Ca(OH)_2$. Show outer electron shells only.

[2]

(c) Slaked lime (solid calcium hydroxide) can be prepared from calcium carbonate, $CaCO_3$, in two stages.

Outline how this could be done in the laboratory. Include an equation for each stage.

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.....

.....[4]

(d) The production of lime water is a small-scale use of calcium hydroxide.

State a large-scale use of calcium hydroxide outside of the laboratory.

.....

.....[1]

[Total: 15]

3 Although compounds are usually classified as having ionic or covalent bonding, often the bonding is somewhere in between these two extremes.

(a) State what is meant by the terms

(i) *ionic bond*,

.....

.....[1]

(ii) *covalent bond*.

.....

.....[2]

(b) Compounds with covalent bonding often have polar bonds. Polarity can be explained in terms of electronegativity.

(i) Explain the term *electronegativity*.

.....

.....

.....[2]

(ii) Use a suitable example to show how the presence of a polar bond can be explained in terms of electronegativity.

You may find it useful to draw a diagram in your answer.

.....

.....

.....[2]

(c) Some polar molecules are able to form hydrogen bonds.
Draw a diagram to show an example of hydrogen bonding.

[2]

[Total: 9]

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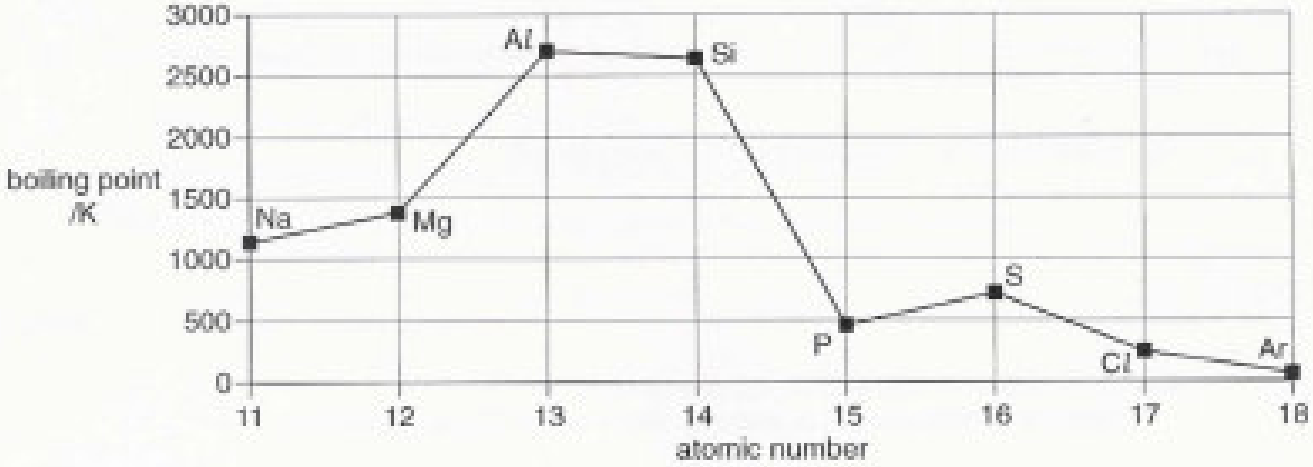
4 The diagram below shows the variation in the boiling points of elements across Period 3 of the Periodic Table.




**(a)** In the table below for the elements Mg, Si and S,

- complete the structure column using the word *giant* or *simple*.
- complete the bonding column using the word *metallic*, *ionic* or *covalent*.

| element | structure | bonding |
|---|---|---|
| Mg | | |
| Si | | |
| S | | |

[3]

**(b)** Explain why silicon has a much **higher** boiling point than phosphorus.

.....

.....

.....

.....[2]

**(c)** Explain why the boiling point **increases** from sodium to aluminium.

.....

.....

.....[2]

[Total: 7]

5 Chlorine can be prepared by reacting concentrated hydrochloric acid with manganese(IV) oxide.

$$4HCl(aq) + MnO_2(s) \rightarrow Cl_2(g) + MnCl_2(aq) + 2H_2O(l)$$

(a) A student reacted 50.0 $cm^3$ of 12.0 mol $dm^{-3}$ hydrochloric acid with an excess of manganese(IV) oxide.

(i) Calculate how many moles of HCl were reacted.

answer = ..... mol [1]

(ii) Calculate the volume of $Cl_2(g)$ produced, in $dm^3$.
Under the experimental conditions, one mole of $Cl_2(g)$ occupies 24.0 $dm^3$.

answer = ..... $dm^3$ [2]

(b) In this reaction, chlorine is oxidised.

Use oxidation numbers to determine what is reduced.

.....

.....

.....

.....[2]

(c) Sodium reacts with chlorine forming the ionic compound sodium chloride, NaCl.

(i) Write an equation, including state symbols, for this reaction.

.....[2]

(ii) Describe the structure of sodium chloride in the solid state. You may find it useful to draw a diagram.

.....

.....[2]

(d) In this question one mark is available for the quality of spelling, punctuation and grammar.

Chlorine gas was bubbled through an aqueous solution of bromide ions and also through an aqueous solution of iodide ions. An organic solvent was then added and each mixture was shaken.

- State what you would see in each case.
- Write equations for any chemical reactions that take place.
- State and explain the trend in reactivity shown by these observations.

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.....[6]

Quality of Written Communication [1]

[Total: 16]

**END OF QUESTION PAPER**

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