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RECOGNISING ACHIEVEMENT

Tuesday 15 May 2012 – Afternoon

AS GCE CHEMISTRY A

F321 Atoms, Bonds and Groups

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour

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F321

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. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- 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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- 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 **12** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 Sulfur, atomic number 16, is found within the Earth's crust. Sulfur is released into the atmosphere at times of volcanic activity.

A sample of sulfur from a volcano was analysed to give the following composition of isotopes.

isotope	abundance (%)
^{32}S	95.02
^{33}S	0.76
^{34}S	4.22

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

.....

.....

.....

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

(b) Calculate the relative atomic mass of the sample of sulfur.

Give your answer to **two** decimal places.

answer = ... **[2]**

(c) John Dalton, an early 19th century scientist, believed that elements were made up of tiny particles called atoms which could not be divided. Nowadays, chemists know of the existence of sub-atomic particles in atoms and in ions.

Complete the table to show the number of sub-atomic particles in the ^{33}S atom and $^{34}S^{2-}$ ion.

	protons	neutrons	electrons
^{33}S			
$^{34}S^{2-}$			

[2]

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(d) Solid sulfur exists as a lattice of S_8 molecules. Each S_8 molecule is a ring of eight atoms.

How many atoms of sulfur are there in 0.0120 mol of S_8 molecules?

answer = ... atoms **[2]**

(e) The only intermolecular forces in solid sulfur are van der Waals'.

(i) Describe how van der Waals' forces arise.

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

(ii) Suggest why there are **no** other intermolecular forces in solid sulfur.

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

(f) Sodium thiosulfate is a compound of sulfur used to develop photographs.

Hydrated sodium thiosulfate has the formula $Na_2S_2O_3 \bullet 5H_2O$.

What is the oxidation number of sulfur in $Na_2S_2O_3 \bullet 5H_2O$?

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

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(g) A student heats 12.41 g of hydrated sodium thiosulfate, $Na_2S_2O_3 \bullet 5H_2O$, to remove the water of crystallisation. A white powder called anhydrous sodium thiosulfate forms.

(i) What does the term *anhydrous* mean?

.....

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

(ii) What is the relative formula mass of $Na_2S_2O_3 \bullet 5H_2O$?

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

(iii) Calculate the expected mass of anhydrous sodium thiosulfate that forms.

mass = ... g **[2]**

(h) Sulfur hexafluoride, SF_6, exists as non-polar covalent molecules with an octahedral shape.

(i) Explain why a molecule of SF_6 has an octahedral shape.

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.....

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

(ii) Fluorine has a higher electronegativity than sulfur, yet SF_6 molecules are non-polar.

Explain what is meant by the term *electronegativity* and suggest why SF_6 molecules are non-polar.

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

[Total: 23]

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TURN OVER FOR QUESTION 2

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2 Chemists can use the Periodic Table to predict the behaviour of elements.

(a) What is the name of the term used to describe the repeating patterns in the Periodic Table?

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

(b) Melting points show a trend across a period.

The table below shows the melting points of three elements in Period 3 of the Periodic Table.

element	aluminium	silicon	phosphorus
melting point / °C	660	1410	44

Explain the trend shown in terms of bonding and structure.



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

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..... **[6]**

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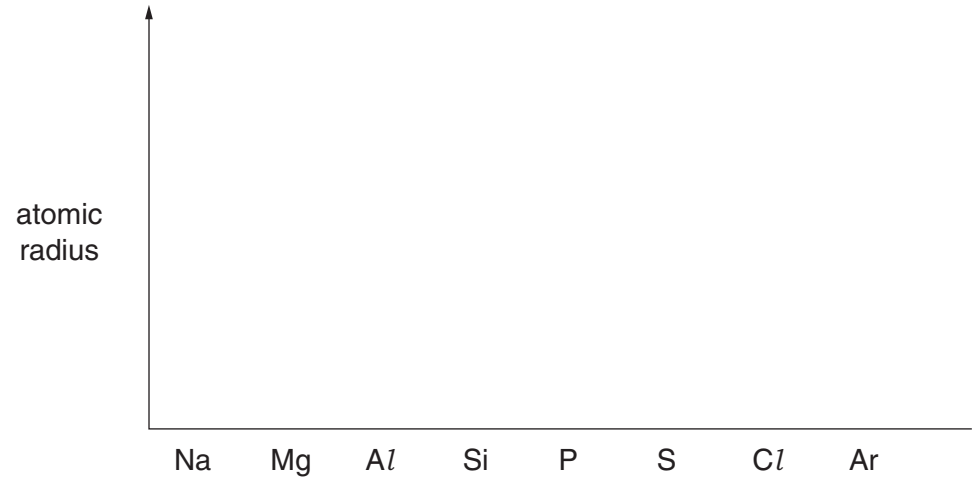
(c) Scientists use 'sketch graphs' to show trends.

(i) Draw a sketch graph to show the general trend in **ionisation energy** across Period 3.



[1]

(ii) Draw a sketch graph to show the general trend in **atomic radius** across Period 3.



[1]

[Total: 9]

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3 Magnesium and strontium are typical Group 2 metals.

(a) Complete the electron configuration of a magnesium atom.

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

(b) The second ionisation energy of magnesium is $1064\,kJ\,mol^{-1}$.

(i) Write an equation to represent the second ionisation energy of magnesium. Include state symbols.

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

(ii) Magnesium has a greater second ionisation energy than strontium.

Explain why.



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

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

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(c) A student watches a demonstration in which strontium is added to water.

The equation for the reaction is shown below.

$$Sr(s) + 2H_2O(l) \rightarrow Sr(OH)_2(aq) + H_2(g)$$

(i) Write the formulae of the aqueous ions formed when this reaction takes place.

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

(ii) In terms of electron transfer, explain why strontium has been oxidised.

.....

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

(iii) Suggest two **compounds** which could be reacted together to produce $Sr(OH)_2$.

.....

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

(d) $Sr(OH)_2$ can react with an acid to form $SrSO_3$.

(i) The systematic name for $SrSO_3$ is strontium sulfate(IV).

Why does the number (IV) have to be used here rather than simply naming this compound as strontium sulfate?

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

(ii) Suggest the formula of the acid used to form $SrSO_3$.

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

[Total: 12]

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4 Chlorine and its compounds have wide uses in chemistry.

(a) In drinking water, HC*l*O kills bacteria.

(i) Write an equation to show how HC*l*O can form in drinking water.

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

(ii) Some scientists believe that chlorine compounds should **not** be present in drinking water.

Suggest **one** reason why scientists may be worried by the presence of these compounds.

.....

.....

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

(b) Chlorine reacts directly with Group 2 elements to form chlorides that are very soluble in water.

Aqueous chloride ions can be detected by adding aqueous silver nitrate.
The appearance of solid silver chloride, AgC*l*, confirms the presence of chloride ions.

(i) State the type of reaction that has taken place.

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

(ii) Write the ionic equation for this reaction.
Include state symbols.

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

(c) A student is given a sample of an unknown Group 2 chloride.

- The student dissolves 2.86 g of the chloride in water.
- The student adds excess aqueous silver nitrate.
- 8.604 g of solid silver chloride, AgC*l*, forms.

(i) Calculate the amount, in moles, of AgC*l* that forms.

The molar mass of AgC*l* = 143.4 g mol^{-1}.

answer = ... mol **[1]**

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(ii) Deduce the amount, in moles, of the Group 2 chloride that the student dissolves.

Hence deduce the relative atomic mass and the identity of the Group 2 metal.
Give the relative atomic mass to **one** decimal place.

You **must** show your working.

relative atomic mass = ...

Group 2 metal = ... **[3]**

(d) Ammonium chloride, NH_4Cl, is a salt which has covalent bonding, dative covalent (coordinate) bonding and ionic bonding.

(i) What is a *dative covalent* (*coordinate*) bond?

.....

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

(ii) Give the formulae of the ions present in NH_4Cl.

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

(iii) Draw a '*dot-and-cross*' diagram to show the bonding in NH_4Cl.
Show the outer electrons only.

[2]

TURN OVER FOR QUESTION 4(e)

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(e) A teacher heats potassium chlorate(V), $KClO_3$. The equation is given below.

$$2KClO_3(s) \longrightarrow 2KCl(s) + 3O_2(g)$$

(i) This is an example of a redox reaction.

What other type of reaction takes place?

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

(ii) The teacher heats 0.824 g of $KClO_3$.

Calculate the volume of oxygen produced, in cm^3, measured at room temperature and pressure.

Give your answer to the **nearest whole number**.

answer = ... cm^3 **[3]**

[Total: 16]

END OF QUESTION PAPER

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