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RECOGNISING ACHIEVEMENT

Friday 13 January 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

F3144201112

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 This question is about iodine and its compounds.

(a) Iodine has a stable isotope with a relative isotopic mass of 127.

In 1986, a radioactive isotope of iodine, with a relative isotopic mass of 131, was released into the atmosphere following an explosion at a nuclear power plant in Chernobyl.

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

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

(ii) Complete the table to show the number of sub-atomic particles in an atom of iodine-127 and in an atom of iodine-131.

	protons	**neutrons**	**electrons**
iodine-127			53
iodine-131			53

[1]

(b) In the human body, iodide ions, I^-, are necessary for the thyroid gland to function correctly. Some countries add potassium iodide, KI, to table salt as a source of iodide ions.

The Guideline Daily Amount, GDA, of iodide ions is 70.0 µg (1 µg = 1×10^{-6} g).

(i) Calculate the mass of KI, in µg, that would be needed to supply the GDA of iodide ions.

Give your answer to **three** significant figures.

answer = ... µg **[2]**

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(ii) Apart from reasons of cost, suggest why some countries do **not** add KI to table salt.

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

(c) When chlorine gas is bubbled through aqueous potassium iodide, a reaction takes place.

(i) Write the ionic equation for this reaction.

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

(ii) At room temperature, chlorine is a gas and iodine is a solid. When heated together, chlorine reacts with iodine to form iodine monochloride, IC*l*.

IC*l* has a higher boiling point than Cl_2.

Explain, in terms of the intermolecular forces present, why IC*l* has a higher boiling point than Cl_2.

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

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

[Total: 9]

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2 Calcium chloride, $CaCl_2$, can be made by different reactions.

A student prepared hydrated calcium chloride by carrying out the following experiment.

Step 1 The student added an excess of a solid calcium compound, **X**, to dilute hydrochloric acid. The mixture fizzed as the solid reacted.

Step 2 The student filtered the mixture to give an aqueous solution of $CaCl_2$.

Step 3 On evaporation, colourless crystals of hydrated calcium chloride were formed.

(a) Describe a chemical test which the student could have carried out to prove that the filtrate contains aqueous chloride ions.

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

(b) A friend of the student suggested that solid **X** was calcium oxide.

State **one** reason why the student's friend was **incorrect** and suggest a possible identity of solid **X**.

reason: .....

.....

solid **X**: ..... **[2]**

(c) Hydrated calcium chloride has a molar mass of 219.1 g mol^{-1}.

(i) What is meant by the term *hydrated* calcium chloride?

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

(ii) Determine the formula of the **hydrated** calcium chloride.

You **must** show your working.

formula = ... **[2]**

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(d) Calcium chloride can also be formed by directly reacting calcium with chlorine gas.

Draw a '*dot-and-cross*' diagram to show the bonding in calcium chloride.

Show outer electrons only.

[2]

(e) The student decided to prepare barium bromide, $BaBr_2$, by directly reacting barium with bromine gas.

The student was unsure whether this preparation would be more reactive or less reactive than the preparation of $CaCl_2$ in **(d)**.

Explain why the student was unsure of the relative reactivity of the two preparations.

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

[Total: 11]

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3 The modern Periodic Table is arranged into blocks of elements based on their electron configuration.

(a) We now know that electrons are in shells; shells have sub-shells and sub-shells have orbitals.

(i) Explain what is meant by the term *orbital*.

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

(ii) Complete the electron configuration below, in terms of sub-shells, for an atom of sulfur.

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

(iii) How many full orbitals are in an atom of sulfur?

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

(b) One mole of sulfur atoms has a mass of 32.1 g.

What is meant by *one mole of substance*?

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

(c) Ionisation energies provide evidence for the order of elements in the modern Periodic Table.

Define the term *first ionisation energy*.

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

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(d) The first ionisation energies and atomic radii of F, Ne and Na are shown below.

element	first ionisation energy / kJ mol^{-1}	atomic radius / nm
F	1681	0.071
Ne	2081	0.065
Na	496	0.191

(i) Explain why there is an increase in first ionisation energy between F and Ne.

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

(ii) Explain why there is a decrease in first ionisation energy between Ne and Na.

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

[Total: 13]

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4 Solid potassium, K, solid potassium bromide, KBr, and ice, H_2O, all exist as lattices.

Their melting points are shown in the table below.

(a) Complete the table.

solid	melting point / °C	type of lattice
K	63	giant metallic
KBr	734	
H_2O	0	

[2]

(b) Explain why there is a difference in the melting points of K, KBr and H_2O.

In your answer you should refer to the types of particle, the types of forces between the particles and the relative strength of the forces between the particles in solid K, KBr and H_2O.

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

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

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(c) Potassium metal reacts with water.

$$2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$$

0.2346 g of potassium is reacted with excess water.

Calculate the volume of gas formed.

The gas volume is measured in cm^3 at room temperature and pressure.

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

[Total: 11]

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5 Ammonia, NH_3, and hydrazine, N_2H_4, are both bases.

(a) Ammonium sulfate, $(NH_4)_2SO_4$, can be prepared by reacting ammonia with sulfuric acid, H_2SO_4.

(i) Why can ammonium sulfate be described as a salt?

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

(ii) A student was given 400 cm^3 of aqueous ammonia solution, $NH_3(aq)$. The student was asked to determine how many moles of NH_3 had been dissolved to prepare the solution.

The student titrated 25.0 cm^3 of $NH_3(aq)$ and found that it reacted exactly with 32.5 cm^3 of 0.100 mol dm^{-3} sulfuric acid.

The equation for this reaction is shown below.

$$2NH_3(aq) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$$

Calculate the amount, in moles, of NH_3 in the original 400 cm^3 solution.

answer = ... mol **[3]**

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(b) The hydrazine molecule, $H_2N–NH_2$, is covalent.

Predict the H–N–H bond angle in a hydrazine molecule.

Explain your answer.

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

(c) Like ammonia, hydrazine is a base that reacts with water to form negative and positive ions.

(i) Write the formula of the negative ion that is formed when hydrazine reacts with water.

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

(ii) Suggest the formula of a positive ion which might form when hydrazine reacts with water.

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

TURN OVER FOR QUESTION 5(d)

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(d) Hydrazine, N_2H_4, has found a use as rocket fuel.

The overall equation for the production of hydrazine is shown below.

$$2NH_3 + NaCl O \rightarrow N_2H_4 + NaCl + H_2O$$

(i) Using oxidation numbers, explain why the above equation represents a redox reaction.

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

(ii) What is the name for $NaClO$?

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

(iii) The overall reaction takes place in two stages.

- In the first stage NH_2Cl is produced.
- In the second stage N_2H_4 is produced.

Some of the hydrazine reacts with NH_2Cl to form ammonium chloride and a colourless gas with a relative molecular mass of 28.0.

Construct the equation for this reaction.

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

[Total: 16]

END OF QUESTION PAPER

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