

**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**




Candidate forename		Candidate surname	
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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. 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.

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  $70.0 \mu\text{g}$  ( $1 \mu\text{g} = 1 \times 10^{-6} \text{g}$ ).

(i) Calculate the mass of KI, in  $\mu\text{g}$ , that would be needed to supply the GDA of iodide ions.

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

answer = .....  $\mu\text{g}$  [2]

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

.....  
..... [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,  $ICl$ .

$ICl$  has a higher boiling point than  $Cl_2$ .

Explain, in terms of the intermolecular forces present, why  $ICl$  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]

- 2 Calcium chloride,  $\text{CaCl}_2$ , 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  $\text{CaCl}_2$ .

**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.

.....  
 ..... [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  $219.1 \text{ g mol}^{-1}$ .

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

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

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

You **must** show your working.

formula = ..... [2]

(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,  $\text{BaBr}_2$ , 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  $\text{CaCl}_2$  in (d).

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

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..... [2]

[Total: 11]

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*.

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

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

1s<sup>2</sup> ..... [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*?

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

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

Define the term *first ionisation energy*.

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

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

element	first ionisation energy / $\text{kJ mol}^{-1}$	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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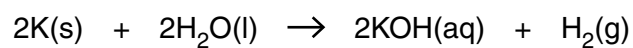
..... [3]

[Total: 13]





(c) Potassium metal reacts with water.



0.2346 g of potassium is reacted with excess water.

Calculate the volume of gas formed.

The gas volume is measured in  $\text{cm}^3$  at room temperature and pressure.

answer = .....  $\text{cm}^3$  [3]

[Total: 11]

5 Ammonia,  $\text{NH}_3$ , and hydrazine,  $\text{N}_2\text{H}_4$ , are both bases.

(a) Ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$ , can be prepared by reacting ammonia with sulfuric acid,  $\text{H}_2\text{SO}_4$ .

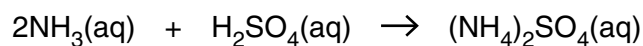
(i) Why can ammonium sulfate be described as a salt?

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

(ii) A student was given  $400\text{ cm}^3$  of aqueous ammonia solution,  $\text{NH}_3(\text{aq})$ . The student was asked to determine how many moles of  $\text{NH}_3$  had been dissolved to prepare the solution.

The student titrated  $25.0\text{ cm}^3$  of  $\text{NH}_3(\text{aq})$  and found that it reacted exactly with  $32.5\text{ cm}^3$  of  $0.100\text{ mol dm}^{-3}$  sulfuric acid.

The equation for this reaction is shown below.



Calculate the amount, in moles, of  $\text{NH}_3$  in the original  $400\text{ cm}^3$  solution.

answer = ..... mol [3]

- (b) The hydrazine molecule,  $\text{H}_2\text{N}-\text{NH}_2$ , 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)**

(d) Hydrazine,  $\text{N}_2\text{H}_4$ , has found a use as rocket fuel.

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



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

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..... [3]

(ii) What is the name for  $\text{NaClO}$ ?

..... [1]

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

- In the first stage  $\text{NH}_2\text{Cl}$  is produced.
- In the second stage  $\text{N}_2\text{H}_4$  is produced.

Some of the hydrazine reacts with  $\text{NH}_2\text{Cl}$  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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