OCR

Friday 23 May 2014 – Morning

AS GCE CHEMISTRY A

F321/01 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

* F 3 2 1 0 1 *

* 1 1 6 8 2 6 6 3 8 0 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found inside 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. If additional answer space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
- 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 Antimony, Sb, has atomic number 51.

(a) Complete the table below to show where antimony is found in the Periodic Table.

Period	Block

[1]

(b) Antimony exists as a mixture of isotopes.

(i) What is meant by the term *isotopes*?

.....

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

(ii) Different isotopes of antimony have the same chemical properties.

Explain why.

.....

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

(iii) Complete the table below to show the atomic structure of ^{121}Sb.

Protons	Neutrons	Electrons

[1]

(c) The relative atomic mass of antimony is 121.8.

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

.....

.....

.....

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

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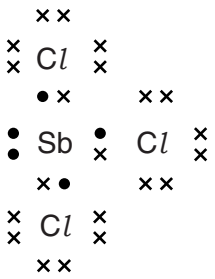
(ii) A sample of antimony, A_r = 121.8, was analysed and was found to consist of 60% ^{121}Sb and one other isotope.

Determine the mass number of the other isotope in the sample of antimony.

mass number of the other antimony isotope = ... **[1]**

(d) Antimony chloride, $SbCl_3$, exists as simple covalent molecules.

A *'dot-and-cross'* diagram of $SbCl_3$ is shown below.



(i) Predict the shape of a molecule of $SbCl_3$.

Explain your answer.

name of shape: .....

explanation: .....

.....

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

(ii) $SbCl_3$ molecules are polar.

Explain why.

.....

.....

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

[Total: 13]

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2 This question is about compounds used in fertilisers.

(a) A compound used as a fertiliser has the following composition by mass:

C, 20.00%; H, 6.67%; N, 46.67%; O, 26.66%.

Calculate the empirical formula of this compound.

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

(b) A salt used as a fertiliser has the empirical formula $H_4N_2O_3$.

Suggest the formulae of the ions present in this salt.

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

(c) Calcium phosphate(V), $Ca_3(PO_4)_2$, is another salt used in fertilisers.

Calcium phosphate(V) can be prepared by reacting together an acid and a base.

(i) Suggest the **formula** of the acid used to prepare $Ca_3(PO_4)_2$.

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

(ii) **Name** a base which could be used to prepare $Ca_3(PO_4)_2$.

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

[Total: 6]

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3 An aqueous solution of aluminium chloride can be prepared by the redox reaction between aluminium metal and dilute hydrochloric acid.

A student reacts 0.0800 mol of aluminium completely with dilute hydrochloric acid to form an aqueous solution of aluminium chloride.

The equation for this reaction is shown below.

$$2Al(s) + 6HCl(aq) \longrightarrow 2AlCl_3(aq) + 3H_2(g)$$

(a) In terms of electron transfer, explain whether aluminium is being oxidised or reduced.

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

(b) Calculate the volume of hydrogen gas formed, in dm^3, at room temperature and pressure.

volume of hydrogen gas formed = ... dm^3 **[2]**

(c) Calculate the mass of $AlCl_3$ formed.

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

mass of $AlCl_3$ formed = ... g **[2]**

(d) Calculate the volume, in cm^3, of 1.20 mol dm^{-3} hydrochloric acid needed to react completely with 0.0800 mol of aluminium.

volume = ... cm^3 **[2]**

[Total: 7]

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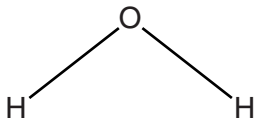
4 Oxides can have different types of bonding.

(a) H_2O has hydrogen bonding.

(i) Complete the diagram below to show hydrogen bonding between the H_2O molecule shown and **one** other H_2O molecule.

Include relevant dipoles and lone pairs.

Label the hydrogen bond.



[2]

(ii) State and explain **two** anomalous properties of ice caused by hydrogen bonding.

1 .....

.....

.....

2 .....

.....

.....

[4]

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(b) Draw a *'dot-and-cross'* diagram to show the bonding in CO_2.

Show outer electrons only.

[1]

(c) Silicon dioxide, SiO_2, has the same structure and bonding as diamond.

State the structure and bonding in SiO_2.

.....

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

(d) Describe and explain the electrical conductivity of sodium oxide, Na_2O, and sodium in their solid and molten states.



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

.....

.....

.....

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.....

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.....

.....

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

[Total: 13]

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5 The Periodic Table is arranged in periods and groups.

(a) Elements in the Periodic Table show a periodic trend in atomic radius.

State and explain the trend in atomic radius from Li to F.



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

trend .....

explanation .....

.....

.....

.....

.....

.....

[3]

(b) **(i)** Complete the electron configuration of a bromide **ion**.

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

(ii) A student adds a small volume of aqueous silver nitrate to an aqueous solution of bromide ions in a test-tube. The student then adds a similar volume of dilute aqueous ammonia to the same test-tube.

Describe what the student would see in the test-tube after the addition of aqueous ammonia.

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

(iii) Write an ionic equation for any precipitation reaction which occurs in the student's tests.

Include state symbols.

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

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(c) The Group 7 element chlorine reacts with sodium hydroxide, NaOH, under different conditions to give different products.

(i) Chlorine reacts with aqueous sodium hydroxide to form bleach.

Write the equation and state the conditions for this reaction.

equation .....

conditions .....

[2]

(ii) Under different conditions, chlorine reacts differently with aqueous sodium hydroxide.

A disproportionation reaction takes place as shown below.

$$3Cl_2(g) + 6NaOH(aq) \rightarrow 5NaCl(aq) + NaClO_3(aq) + 3H_2O(l)$$

State what is meant by disproportionation and show that disproportionation has taken place in this reaction.

Use oxidation numbers in your answer.

.....

.....

.....

.....

.....

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

[Total: 11]

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6 This question is about Group 2 elements and compounds.

(a) Group 2 carbonates undergo thermal decomposition.

(i) Write the equation for the thermal decomposition of calcium carbonate.

Include state symbols.

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

(ii) Write the formula of the Group 2 carbonate which decomposes at the highest temperature.

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

(b) Hydrated strontium chloride, $SrCl_2 \bullet 6H_2O$, has a molar mass of 266.6 g mol^{-1}.

A student heats 5.332 g of $SrCl_2 \bullet 6H_2O$.

The $SrCl_2 \bullet 6H_2O$ loses some of its water of crystallisation forming 3.892 g of a solid product.

Use the information above to determine the formula of the solid product.

Show your working.

formula of solid product = ... **[3]**

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(c) A chemist carries out reactions of barium and barium nitride, Ba_3N_2.

Reaction 1 Barium is reacted with water.

Reaction 2 Barium nitride is reacted with water, forming an alkaline solution and an alkaline gas.

Reaction 3 Barium is reacted with an excess of oxygen at 500°C, forming barium peroxide, BaO_2.

(i) Write equations for **Reaction 1** and **Reaction 2**.

Ignore state symbols.

Reaction 1: .....

Reaction 2: .....

[3]

(ii) Predict the structure and bonding of Ba_3N_2.

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

(iii) BaO_2 formed in **Reaction 3** contains barium and peroxide ions.
The peroxide ion has the structure $[O–O]^{2–}$.

Suggest a *'dot-and-cross'* diagram for BaO_2.

Show outer shell electrons only.

[1]

[Total: 10]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page. The question number(s) must be clearly shown in the margin.

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