OCR
Oxford Cambridge and RSA

Friday 22 May 2015 – 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 *

* 4 9 8 9 2 4 7 7 7 9 *

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 **16** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 This question is about the elements with atomic numbers between 58 and 70.

(a) Cerium, atomic number 58, is a metal.

Complete the table to show the relative charge of each particle and the number of each particle found in a $^{140}Ce^{2+}$ ion.

Particle	Relative charge of each particle	Number of each particle present in a $^{140}Ce^{2+}$ ion
proton		
neutron		
electron		

[2]

(b) Cerium behaves as a typical metal when it reacts with dilute sulfuric acid to form the salt cerium(III) sulfate and a second product.

(i) Identify the second product.

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

(ii) Write the formula of cerium(III) sulfate and, explain what has happened to the cerium in this reaction in terms of the number of electrons transferred.

Formula .....

Explanation .....

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

(iii) How has a salt been formed in this reaction?

.....

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

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(c) Europium, atomic number 63, reacts with oxygen at room temperature.

$$4Eu + 3O_2 \rightarrow 2Eu_2O_3$$

Calculate the volume of oxygen, in cm^3, required to fully react with 9.12 g of europium at room temperature and pressure.

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

(d) A compound of thulium, atomic number 69, has the following composition by mass:

O 30.7% S 15.4% Tm 53.9%

(i) State what is meant by the term *empirical formula*.

.....

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

(ii) Determine the empirical formula of the compound.

Show your working.

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

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(e) Ytterbium, atomic number 70, is the first element in the Periodic Table to have the first four shells full.

(i) State the number of electrons in the **fourth** shell of ytterbium.

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

(ii) How many orbitals are there in the **third** shell of ytterbium?

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

[Total: 13]

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2 This question is about compounds of Group 3 elements.

(a) Aluminium will combine directly with fluorine.

Write the equation for the reaction between aluminium and fluorine.

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

(b) Solid aluminium fluoride has a giant ionic lattice structure.

(i) Describe what is meant by the term *ionic lattice*, in terms of the type and arrangement of particles present.

.....

.....

.....

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

(ii) Draw a '*dot-and-cross*' diagram for aluminium fluoride.

Show outer electrons only.

[2]

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(c) Solid boron tribromide has a simple molecular lattice structure. The atoms are held together by covalent bonds.

(i) What is meant by the term *covalent bond*?

.....

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

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in a boron tribromide molecule.

Show outer electrons only.

[1]

(d) State whether the following substances conduct electricity when solid or molten, and explain your answers in terms of the particles involved:

- aluminium
- aluminium fluoride
- boron tribromide.

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

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

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(e) Aluminium has 13 successive ionisation energies.

(i) Write the equation for the **third** ionisation energy of aluminium.

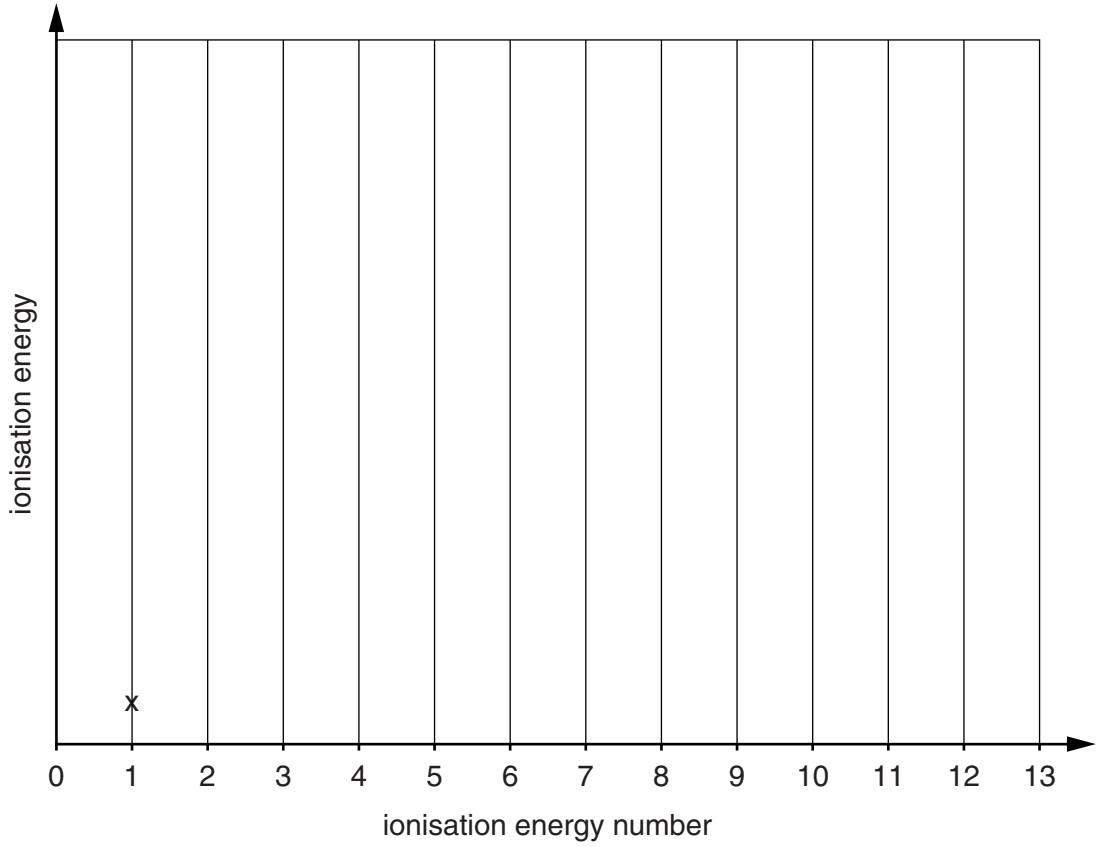
Include state symbols.

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

(ii) On the axes below, add crosses to show the 13 successive ionisation energies of aluminium.

The value for the first ionisation energy has been completed for you.

You do not have to join the crosses.



[2]

[Total: 15]

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3 This question is about Group 7 elements.

(a) Chlorine can be made by the redox reaction below.

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

Using oxidation numbers, show what has been oxidised and what has been reduced in this reaction.

Oxidised .....

.....

Reduced .....

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

(b) Complete the electron configuration of a manganese atom.

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

(c) Chlorine gas can be added to a cold, dilute alkaline solution to form bleach.

Write the equation for this reaction.

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

(d) A student bubbles chlorine gas through aqueous potassium iodide. A reaction takes place.

(i) State what the student would observe.

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

(ii) Write the ionic equation for this reaction.

Include state symbols.

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

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(e) Chlorine gas reacts with methane. One of the products is dichloromethane, CH_2Cl_2.

(i) Chlorine is more electronegative than carbon and hydrogen, which have approximately equal electronegativity values.

Explain what is meant by the term *electronegativity.*

.....

.....

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

(ii) Draw a 3-D diagram of a molecule of CH_2Cl_2.

Use partial charges to indicate polar bonds.

[2]

(iii) Explain why a CH_2Cl_2 molecule is polar.

.....

.....

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

(f) Bromine has two isotopes, Br–79 and Br–81. The relative atomic mass of bromine is 79.9.

Calculate the percentage of Br–79 atoms in a sample of bromine.

Answer = ... % **[1]**

[Total: 12]

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4 A student was given 200 cm^3 of solution **X** in which sodium hydroxide, NaOH, and sodium hydrogencarbonate, $NaHCO_3$, had **both** been dissolved.

The student carried out **two different** titrations on samples of solution **X** using 0.100 mol dm^{-3} sulfuric acid, H_2SO_4.

- In the first titration, **both** NaOH **and** $NaHCO_3$ were neutralised.
- In the second titration, **only** NaOH was neutralised.

The student's results for the titrations of 25.0 cm^3 samples of solution **X** are shown.

volume of H_2SO_4 needed to neutralise **both** NaOH **and** $NaHCO_3$	29.50 cm^3
volume of H_2SO_4 needed to neutralise **only** NaOH	18.00 cm^3

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

$$2NaHCO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l) + 2CO_2(g)$$

(a) (i) Calculate the amount, in mol, of H_2SO_4 used to neutralise **only** the NaOH in 25.0 cm^3 of solution **X**.

Amount = ... mol **[1]**

(ii) Calculate the concentration, in mol dm^{-3}, of NaOH in solution **X**.

Concentration = ... mol dm^{-3} **[1]**

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(b) (i) Calculate the amount, in mol, of $NaHCO_3$ in the 200 cm^3 of solution **X**.

Amount = ... mol **[2]**

(ii) Calculate the mass of $NaHCO_3$ in the 200 cm^3 of solution **X**.

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

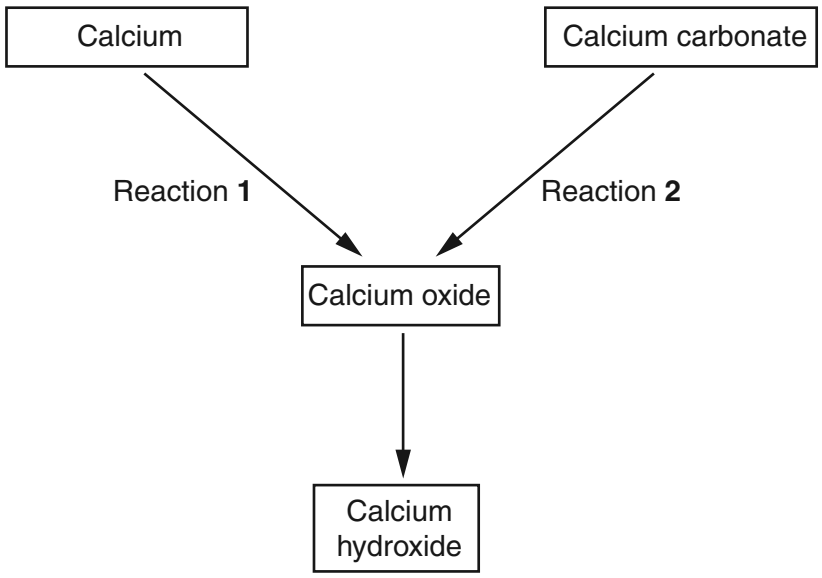
Mass = ... g **[1]**

[Total: 5]

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5 Calcium is in Group 2 of the Periodic Table.

The diagram shows some reactions of calcium and its compounds.



(a) Reactions **1** and **2** both form calcium oxide.

(i) Write the equation for reaction **1**.

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

(ii) What type of reaction is reaction **2**?

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

(b) Calcium hydroxide is both a base and an alkali. Refer to any relevant ions in your answer.

Explain what is meant by the terms *base* and *alkali*.

Base .....

.....

Alkali .....

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

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(c) A student prepared some calcium hydroxide by adding a small piece of calcium to a large excess of water.

Describe what the student would observe and write the equation for the reaction.

Observation .....

.....

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

(d) A student prepares a solution of calcium nitrate from calcium carbonate.

What reagent would the student need to use?

Write the equation for the reaction.

Reagent .....

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

[Total: 8]

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6 This question is about the attraction between particles.

(a) State how and explain why the attraction between nuclei and outermost electrons in gaseous atoms varies across Period 3.

.....

.....

.....

.....

.....

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

(b) The table shows the boiling points of ammonia, fluorine and bromine.

	Boiling point/°C
ammonia, NH_3	– 33
fluorine, F_2	– 188
bromine, Br_2	59

Explain the different boiling points of NH_3, F_2 and Br_2.

Include the names of any relevant forces and particles.

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

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

[Total: 7]

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 margins.

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