OCR
Oxford Cambridge and RSA

Friday 26 May 2017 – 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 *

* 6 6 7 9 4 7 2 7 5 8 *

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(s) 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.

Answer **all** the questions.

1 Molybdenum (atomic number 42) and cobalt (atomic number 27) are metals used in the manufacture of steel.

(a) Molybdenum has many isotopes.

(i) Explain what is meant by the term *isotopes*?

.....

.....

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

(ii) Complete the table for an atom and an ion of molybdenum.

	Protons	**Neutrons**	**Electrons**
^{98}Mo	.....	.....	.....
.....	.....	54	40

[2]

(b) Which isotope is used as the standard measurement of relative isotopic mass?

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

(c) In the manufacture of molybdenum metal, an oxide of molybdenum, MoO_3, is reacted with hydrogen gas.

$$MoO_3(s) + 3H_2(g) \rightarrow Mo(s) + 3H_2O(g)$$

(i) Using **oxidation numbers**, show what has been oxidised and what has been reduced in this reaction.

oxidised .....

.....

reduced .....

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

(ii) A chemist reacts 2.878 g of MoO_3 with hydrogen gas.

Calculate the volume of hydrogen gas, in cm^3, required to completely react with 2.878 g of MoO_3 at room temperature and pressure.

volume of hydrogen gas = ... cm^3 **[3]**

(d) Complete the electron configuration of a cobalt atom.

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

(e) Compounds of cobalt, such as hydrated cobalt(II) sulfate, $CoSO_4 \cdot xH_2O$, are used in the manufacture of pigments.

A student wanted to find the value of ***x***. The student heats 5.62 g of hydrated cobalt(II) sulfate to remove the water of crystallisation. The student removes 2.52 g of water.

Calculate the value of ***x*** in $CoSO_4 \cdot xH_2O$.

x = ... **[3]**

[Total: 13]

2 This question is about simple molecular compounds.

(a) Pairs of electrons in molecules can be described as bonded pairs or lone pairs.

(i) In the table below, show the numbers of bonded pairs and lone pairs around the central atom in each molecule.

Molecule	NCl_3	$SiCl_4$	BCl_3	Cl_2O
Number of bonded pairs				
Number of lone pairs				

[2]

(ii) **Name** the shape and the expected bond angle of each molecule.

Predict which molecules are polar by placing a tick (✓) in the last column.

Molecule	**Name of shape of molecule**	**Expected bond angle**	**Polar molecule(s) (✓)**
NCl_3			
$SiCl_4$			
BCl_3			
Cl_2O			

[6]

(b) Draw a diagram to show the strongest type of intermolecular bonding between **two** molecules of ammonia.

Include relevant dipoles and lone pairs.

Label the bonding between the two molecules.

[2]

(c) BCl_3 gas reacts with water to form a solution containing two acidic products.

One of the products, **A**, has the following percentage composition by mass:

B 17.48%; O, 77.67%; H 4.85%

(i) Calculate the empirical formula of compound **A**.

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

(ii) The molecular formula of compound **A** is the same as the empirical formula.

Suggest an equation, including state symbols, for the reaction between BCl_3 and water.

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

[Total: 14]

3 The elements sodium to chlorine are in Period 3 of the Periodic Table.

(a) The table below shows the melting points of some elements of Period 3.

Element	Na	Mg	A*l*	Si	P	S	C*l*
Melting point / °C	98	649	660	1410	44	113	–101
Structure							
Electrical conductivity							

- Complete the *structure* row of the table using:

  S for a simple molecular structure
  G for a giant structure.

- Complete the *electrical conductivity* row of the table to show which elements conduct electricity in the solid state by using a tick (✓). **[2]**

(b) The melting point of a substance is dependent upon the forces between particles.

Name the forces and the particles in the structures of chlorine and silicon, and explain why chlorine has a much lower melting point than silicon.

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

(c) Sodium and magnesium have metallic bonding.

(i) Draw a **labelled** diagram to show the metallic bonding of magnesium.

Show the correct charges on any particles shown in your diagram.

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

[2]

(ii) Explain why the melting point of magnesium is higher than that of sodium.

In your answer, refer to the particles and the forces acting between them.

.....

.....

.....

.....

.....

.....

.....

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

(d) In the Periodic Table, elements show periodicity.

Explain what is meant by the term *periodicity*.

.....

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

[Total: 13]

4 This question is about Group 2 elements and their compounds.

(a) A chemist adds 0.115 g of a Group 2 element to water and the resulting solution is made up to 400 cm^3 by adding distilled water.

The equation for the reaction is shown below. M represents the Group 2 element.

$$M(s) + 2H_2O(l) \longrightarrow M(OH)_2(aq) + H_2(g)$$

The concentration of hydroxide ions, $OH^-(aq)$, in the solution is 6.56×10^{-3} mol dm^{-3}.

Determine the molar mass of M to **one** decimal place.

Use your answer to identify M.

molar mass of M = ... g mol^{-1}

identity of M = ... **[3]**

(b) A student bubbles chlorine gas through an aqueous solution of magnesium iodide, $MgI_2(aq)$.

(i) Describe what the student would see.

.....

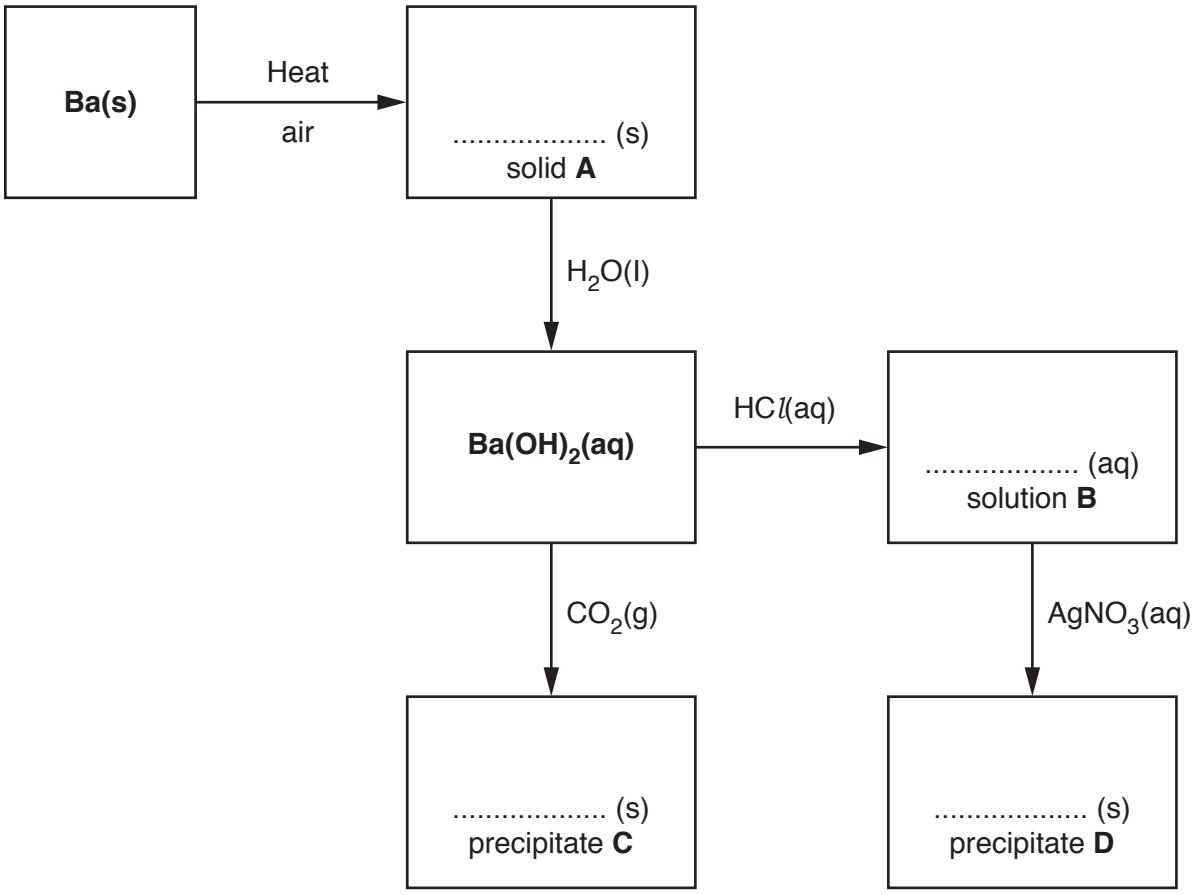
..... **[1]**

(ii) Write an ionic equation, including state symbols, for the reaction taking place.

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

(c) The flowchart below shows some reactions involving barium.

(i) Write the formulae of the substances **A – D** in the boxes.



[4]

(ii) Suggest the formula of the other substance formed when $AgNO_3(aq)$ is added to solution **B**.

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

(d) Ionisation energy is one factor responsible for the trend in reactivity of Group 2 elements.

(i) Define, in words, the term ***first*** *ionisation energy*.

.....

.....

.....

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

(ii) Write an equation, including state symbols, for the **second** ionisation energy of strontium.

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

(iii) A chemist investigates the trend in reactivity of the Group 2 elements by adding each element to separate samples of dilute hydrochloric acid.

- Describe what the chemist would see when magnesium is added to dilute hydrochloric acid.
- Describe the trend in reactivity that the chemist would see between the Group 2 elements.
- Explain the trend in reactivity down Group 2.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

[Total: 20]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

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