OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY

Chemistry Foundation

2811

Monday   **4 JUNE 2001**   ...   1 hour 30 minutes

Additional materials.
Calculator
Data Sheet for Chemistry
Candidates answer on the question paper

Candidate Name	Centre Number	Candidate Number

TIME   1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

* Write your name in the space above.
* Write your Centre number and Candidate number in the boxes above.
* Answer **all** the questions.
* Write your answers, in blue or black ink, in the spaces on the question paper.
* Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

* The number of marks is given in brackets [ ] at the end of each question or part question.
* The total number of marks for this paper is 90.
* You will be awarded marks for the quality of written communication where an answer requires a piece of extended writing.
* You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	12	
2	9	
3	12	
4	16	
5	9	
6	8	
7	11	
8	13	
TOTAL	90	

This question paper consists of 13 printed pages, 2 lined pages and 1 blank page.

Answer **all** questions.

1 **(a)** State what is meant by

(i) an *ionic bond,*

....

....[1]

(ii) a *covalent bond.*

....

....[2]

(b) Draw 'dot-and-cross' diagrams to show the bonding in sodium chloride and hydrogen chloride. You should show outer electron shells only.

sodium chloride	hydrogen chloride

[3]

(c) **(i)** State what is meant by an *orbital.*

....

....[1]

(ii) Draw diagrams to show the shape of an s orbital and of a p orbital.

s orbital	p orbital

[2]

(iii) Complete the table below to show how many electrons **completely** fill each of the following

	number of electrons
a p **orbital**	
a d **sub-shell**	.
the third **shell** (n = 3)	

[3]

[Total : 12]

[Turn over

2 The table below shows the boiling points of the elements sodium to chlorine in Period 3 of the Periodic Table.

element	Na	Mg	Al	Si	P	S	Cl
boiling point/°C	883	1107	2467	2355	280	445	−35
bonding		.					
structure							

(a) **(i)** Complete the *bonding* row of the table using

• **M** for *metallic bonding*,
• **C** for *covalent bonding*. [1]

(ii) Complete the *structure* row of the table using

• **S** for a *simple molecular structure*,
• **G** for a *giant structure*. [1]

(b) State what is meant by *metallic bonding*. You should draw a diagram as part of your answer.

....

....

....[3]

(c) Explain, in terms of their structure and bonding, why the boiling point of

(i) phosphorus is much **lower** than that of silicon,

....

....

....[2]

(ii) aluminium is much **higher** than that of magnesium.

....

....

....[2]

[Total : 9]

3 Hydrogen chloride, HC*l*, is a colourless gas which dissolves very readily in water forming hydrochloric acid. [1 mol of gas molecules occupy 24.0 dm^3 at room temperature and pressure r.t.p.]

(a) At room temperature and pressure, 1.00 dm^3 of water dissolved 432 dm^3 of hydrogen chloride gas.

(i) How many moles of hydrogen chloride dissolved in the water?

[1]

(ii) The hydrochloric acid formed has a volume of 1.40 dm^3. What is the concentration, in mol dm^{-3}, of the hydrochloric acid?

[1]

(b) In solution, the molecules of hydrogen chloride ionise.

$$HCl(aq) \longrightarrow H^+(aq) + Cl^-(aq)$$
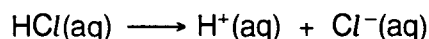
Describe a simple test to confirm the presence of chloride ions.

....

....

....[2]

(c) Hydrochloric acid reacts with magnesium oxide, MgO, and magnesium carbonate, MgCO$_3$.

For each reaction, state what you would see and write a balanced equation.

(i) MgO

observation ....

....

equation ....[2]

(ii) MgCO$_3$

observation ....

....

equation ....[2]

[Total : 8]

[Turn over

4 Sulphur and sulphur compounds are common in the environment.

(a) A sample of sulphur from a volcano contained 88.0% by mass of ^{32}S and 12.0% by mass of ^{34}S.

(i) Complete the table below to show the atomic structure of each isotope of sulphur.

isotope	number of		
	protons	neutrons	electrons
^{32}S			
^{34}S			

[2]

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

....

....

....

....[3]

(iii) Calculate the relative atomic mass of the volcanic sulphur. Your answer should be given to three significant figures.

[2]

(b) Rotten eggs smell of hydrogen sulphide, H_2S, which is a poisonous gas.

A 'dot-and-cross' diagram, showing outer shell electrons only, of a hydrogen sulphide molecule is shown below.
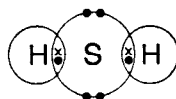
Draw a diagram to show the likely shape and bond angle of a hydrogen sulphide molecule. Explain how you have made your choice.

explanation ....

....

....[3]

(c) Every year, between 20 and 50 million tonnes of sulphur are released into the atmosphere from the oceans in the form of DMS, a compound of carbon, hydrogen and sulphur. DMS causes the bracing feeling by the sea.

DMS has the percentage composition by mass of C: 38.6%; H: 9.7%; S: 51.7%.

Calculate the empirical formula of DMS.

[2]

[Total : 12]

[Turn over

5 The reaction between barium and water is a redox reaction.

$$Ba(s) + 2H_2O(l) \longrightarrow Ba(OH)_2(aq) + H_2(g)$$
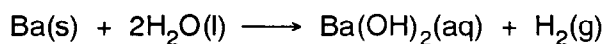
(a) Explain, in terms of electrons, what is meant by

(i) oxidation,

....[1]

(ii) reduction.

....[1]

(b) Which element has been oxidised in this reaction? Deduce the change in its oxidation state.

element ....

oxidation state changes from .... to ....   [2]

(c) A student reacted 2.74 g of barium with water to form 250 cm^3 of aqueous barium hydroxide.

(i) Calculate how many moles of Ba reacted.

[1]

(ii) Calculate the volume of H$_2$ that would be produced at room temperature and pressure (r.t.p.). [1 mol of gas molecules occupies 24.0 dm^3 at r.t.p.]

[1]

(iii) Calculate the concentration, in mol dm^{-3}, of Ba(OH)$_2$ that was formed.

[1]

(iv) The solution of barium hydroxide is alkaline. Identify a compound that could be added to neutralise this solution and write a balanced equation for the reaction that would take place.

compound ....

equation ....[2]

(d) The Group 2 elements react more vigorously with water as the group is descended. This can be explained in part by using ionisation energies.

(i) Define the term *first ionisation energy*.

....

....

....

....[3]

(ii) Explain, in terms of ionisation energies, why the Group 2 elements become more reactive as the group is descended.

....

....

....

....

....[4]

[Total : 16]

[Turn over

6 The boiling points of water, hydrogen chloride and argon are shown in Table 7.1 below.

Table 7.1

substance	H_2O	HCl	Ar
boiling point/°C	100	–85	–186
total number of electrons	10	18	18

(a) H_2O, HCl and Ar all have van der Waals' forces.

Outline how van der Waals' forces arise between molecules.

....

....

....

....[2]

(b) Liquid H_2O has additional intermolecular forces.

(i) What are these forces?

....[1]

(ii) Explain, with the aid of a diagram, how these forces arise between molecules of $H_2O(l)$.

....

....

....

....

....[5]

(c) Liquid HC*l* also has additional intermolecular forces. What are these forces?

....[1]

(d) Explain the variation in boiling points shown in Table 7.1.

....

....

....[2]

[Total : 11]

[Turn over

7 The bones in an adult human skeleton have a mass of approximately 9 kg. Of this, 1 kg is calcium.

(a) The calcium in bones is present as calcium ions, Ca^{2+}.

Complete the electronic configurations of the following.

a calcium **atom**: $1s^2$ ....

a calcium **ion**: $1s^2$ .... [2]

(b) Calculate the approximate number of calcium ions in an adult human skeleton.
[The Avogadro constant, $L = 6 \times 10^{23}$ mol^{-1}.]

[2]

(c) Suggest why calcium **atoms** are **not** present in a human skeleton.

....

....

....[1]

(d) The calcium in bones can be assumed to be present as calcium phosphate. A phosphate ion has the formula PO_4^{3-}.

(i) What is the formula of calcium phosphate?

....[1]

(ii) Estimate the percentage, by mass, of calcium phosphate in an adult human skeleton.

[3]

[Total : 9]

8 Compare and explain the electrical conductivity of sodium chloride, diamond and graphite. In your answer, you should consider the structure and bonding of each of these materials.

In this question, 2 marks are available for the quality of written communication.

[Total : 13]

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

[Turn over