

Atoms, elements and compounds

Question Paper 3

Level	IGCSE
Subject	Chemistry
ExamBoard	CIE
Topic	Atoms,Elements and Compounds
Sub-Topic	
Paper	(Extended) Theory
Booklet	Question Paper 3

TimeAllowe **87 minutes**

d: Score: **/ 72**

Percentage: **/100**

1 Substances can be classified as:

elements mixtures

Elements can be divided into:

metals non-

(a) Define each of the following terms.

(i) *element*

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

(ii) *compound*

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

(iii) *mixture*

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

(b) Classify each of the following as either an element, compound or mixture.

(i) brass [1]

(ii) carbon dioxide [1]

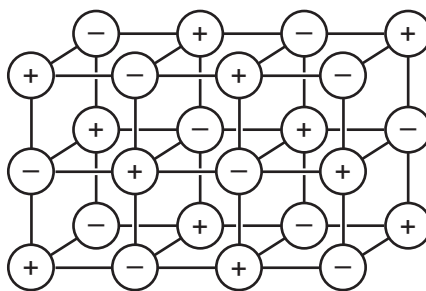
(iii) copper [1]

(c) Which physical property is used to distinguish between metals and non-metals?
It is possessed by all metals but by only one non-metal.

..... [1]

[Total: 9]

2 (a) The diagram shows the lattice of a typical ionic compound.



(i) Explain the term *ionic lattice*.

.....
 [2]

(ii) In this lattice, the ratio of positive ions to negative ions is 1:1.
 In the lattice of a different ionic compound, the ratio of positive ions to negative ions is 1:2.
 Suggest why this ratio varies in different ionic compounds.

..... [1]

(iii) Give **three** physical properties of ionic compounds.

.....

 [3]

(b) Strontium oxide is an ionic compound. Draw a diagram which shows its formula, the charges on the ions and the arrangement of the **valency** electrons around the negative ion.

The electron distribution of a strontium atom is 2 + 8 + 18 + 8 + 2.

Use o to represent an electron from a strontium atom.

Use x to represent an electron from an oxygen atom.

[3]

[Total: 9]

3 Diamond and graphite are different forms of the same element, carbon. Explain the following in terms of their structure.

(a) Graphite is a soft material which is used as a lubricant.

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

(b) Diamond is a very hard material which is used for drilling and cutting.

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

(c) Graphite is a good conductor of electricity and diamond is a poor conductor.

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

[Total: 6]

- 4 Both strontium and sulfur have chlorides of the type XCl_2 . The table below compares some of their properties.

	strontium chloride	sulfur chloride
appearance	white crystals	red liquid
formula	$SrCl_2$	SCl_2
melting point/ $^{\circ}C$	874	-120
boiling point/ $^{\circ}C$	1250	59
conductivity of liquid	good	poor
solubility in water	dissolves to form a neutral solution	reacts to form a solution of pH 1

- (a) Use the data in the table to explain why sulfur chloride is a liquid at room temperature, $25^{\circ}C$.

.....
 [2]

- (ii) Strontium is a metal and sulfur is a non-metal. Explain why both have chlorides of the type XCl_2 .
 The electron distribution of a strontium atom is $2 + 8 + 18 + 8 + 2$.

.....

 [2]

- (iii) Deduce the name of the acidic compound formed when sulfur chloride reacts with water.

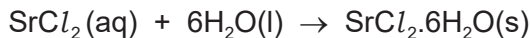
..... [1]

- (iv) Explain the difference in the electrical conductivity of liquid strontium chloride and liquid sulfur chloride.

.....

 [3]

- (b) Strontium chloride-6-water can be made from the insoluble compound, strontium carbonate, by the following reactions.



The following method was used to prepare the crystals.

- 1 Add excess strontium carbonate to hot hydrochloric acid.
- 2 Filter the resulting mixture.
- 3 Partially evaporate the filtrate and allow to cool.
- 4 Filter off the crystals of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$.
- 5 Dry the crystals between filter papers.

- (i) How would you know when excess strontium carbonate had been added in step 1?

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

- (ii) Why is it necessary to filter the mixture in step 2?

..... [1]

- (iii) In step 3, why partially evaporate the filtrate rather than evaporate to dryness?

..... [1]

- (c) In the above experiment, 50.0 cm^3 of hydrochloric acid of concentration 2.0 mol/dm^3 was used. 6.4 g of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ was made.
Calculate the percentage yield.

number of moles of HCl used =

number of moles of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ which could be formed =

mass of one mole of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ is 267 g

theoretical yield of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ =g

percentage yield =% [4]

[Total: 15]

5 This question is concerned with the elements in Period 5, Rb to Xe.

(a) The electron distributions of some of these elements are given in the following list.

- element A 2 +
- element B 2 +
- element C 2 +
- element D 2 +
- element E 2 + 8 + 18 + 18 + 4
- element F 2 + 8 + 18 + 18 + 7

(i) Identify element C. [1]

(ii) Which element in the list does not form any compounds?
..... [1]

(iii) Which element in the list forms a chloride of the type $XC l_2$?
..... [1]

(iv) Which **two** elements would react together to form a compound of the type XY_4 ?
..... [1]

(v) Which element in the list would react with cold water to form an alkaline solution and hydrogen?
..... [1]

(b) Predict **two** differences in physical properties and **two** differences in chemical properties between rubidium and the transition metal niobium.

physical

.....

.....

chemical

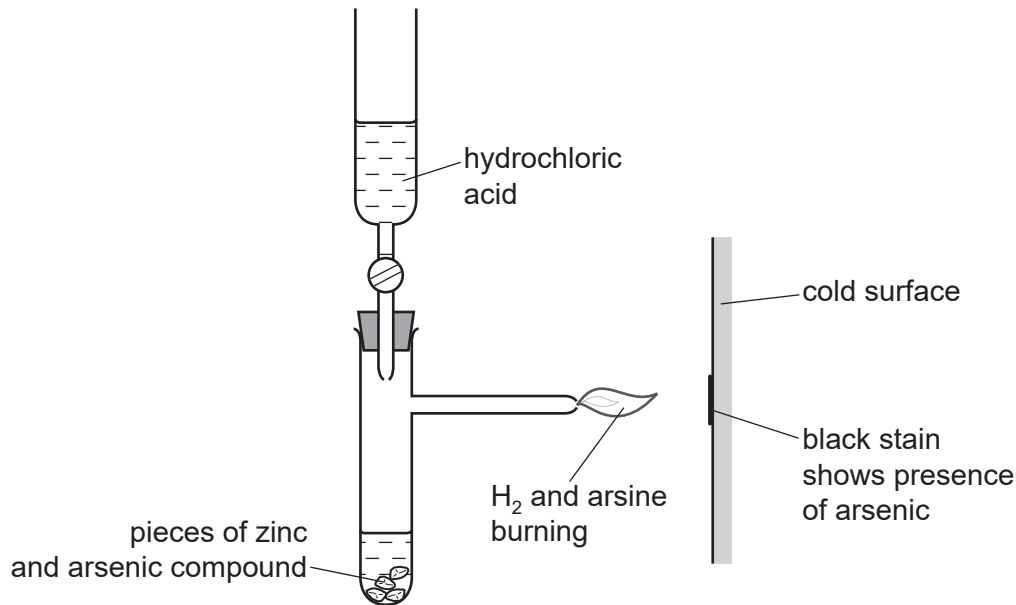
.....

..... [4]

[Total: 9]

6 Until recently, arsenic poisoning, either deliberate or accidental, has been a frequent cause of death. The symptoms of arsenic poisoning are identical with those of a common illness, cholera. A reliable test was needed to prove the presence of arsenic in a body.

(a) In 1840, Marsh devised a reliable test for arsenic.



Hydrogen is formed in this reaction. Any arsenic compound reacts with this hydrogen to form arsine which is arsenic hydride, AsH_3 . The mixture of hydrogen and arsine is burnt at the jet and arsenic forms as a black stain on the glass.

(i) Write an equation for the reaction which forms hydrogen.

..... [2]

(ii) Draw a diagram which shows the arrangement of the outer (valency) electrons in one molecule of the covalent compound arsine.

The electron distribution of arsenic is $2 + 8 + 18 + 5$.

Use x to represent an electron from an arsenic atom.

Use o to represent an electron from a hydrogen atom.

[2]

(b) Another hydride of arsenic has the composition below.

arsenic 97.4 % hydrogen 2.6 %

(i) Calculate the empirical formula of this hydride **from the above data**.
Show your working.

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

(ii) The mass of one mole of this hydride is 154 g. What is its molecular formula?

..... [1]

(iii) Deduce the structural formula of this hydride.

[1]

(c) Hair is a natural protein. Hair absorbs arsenic from the body. Analysis of the hair provides a measurement of a person's exposure to arsenic. To release the absorbed arsenic for analysis, the protein has to be hydrolysed.

(i) What is the name of the linkage in proteins?

..... [1]

(ii) Name a reagent which can be used to hydrolyse proteins.

..... [1]

(iii) What type of compound is formed by the hydrolysis of proteins?

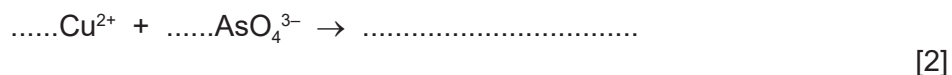
..... [1]

(d) In the 19th Century, a bright green pigment, copper(II) arsenate(V) was used to kill rats and insects. In damp conditions, micro-organisms can act on this compound to produce the very poisonous gas, arsine.

(i) Suggest a reason why it is necessary to include the oxidation states in the name of the compound.

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

(ii) The formula for the arsenate(V) ion is AsO_4^{3-} . Complete the ionic equation for the formation of copper(II) arsenate(V).



[Total: 14]

7 The structure of an element or compound determines its physical properties.
Scandium fluoride and silicon(IV) oxide have giant structures.

(a) Scandium fluoride is an ionic compound.

(i) The valency of scandium is three. Draw a diagram which shows the formula of the compound, the charges on the ions and the arrangement of the valency electrons around the negative ion.

Use x to represent an electron from a scandium atom.

Use o to represent an electron from a fluorine atom.

[3]

(ii) The melting point of scandium fluoride is 1552 °C. Explain why scandium fluoride has a high melting point.

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

(b) Silicon(IV) oxide has a macromolecular structure.

(i) Describe the structure of silicon(IV) oxide. You may use a diagram.

[3]

(ii) How does the electrical conductivity of these two compounds differ?

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

(iii) Explain the difference in conductivity.

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

[Total: 10]