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]

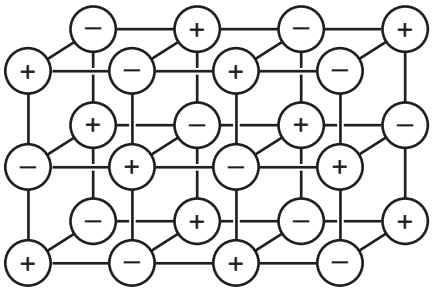
(iii) copper ..... [1]

(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 / °C	874	–120
boiling point / °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 °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.

$SrCO_3(s) + 2HCl(aq) \rightarrow SrCl_2(aq) + CO_2(g) + H_2O(l)$

$SrCl_2(aq) + 6H_2O(l) \rightarrow SrCl_2.6H_2O(s)$

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 $SrCl_2.6H_2O$.
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 $SrCl_2.6H_2O$ was made.
Calculate the percentage yield.

number of moles of HCl used = ...

number of moles of $SrCl_2.6H_2O$ which could be formed = ...

mass of one mole of $SrCl_2.6H_2O$ is 267 g

theoretical yield of $SrCl_2.6H_2O$ = ...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 XCl_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 .....

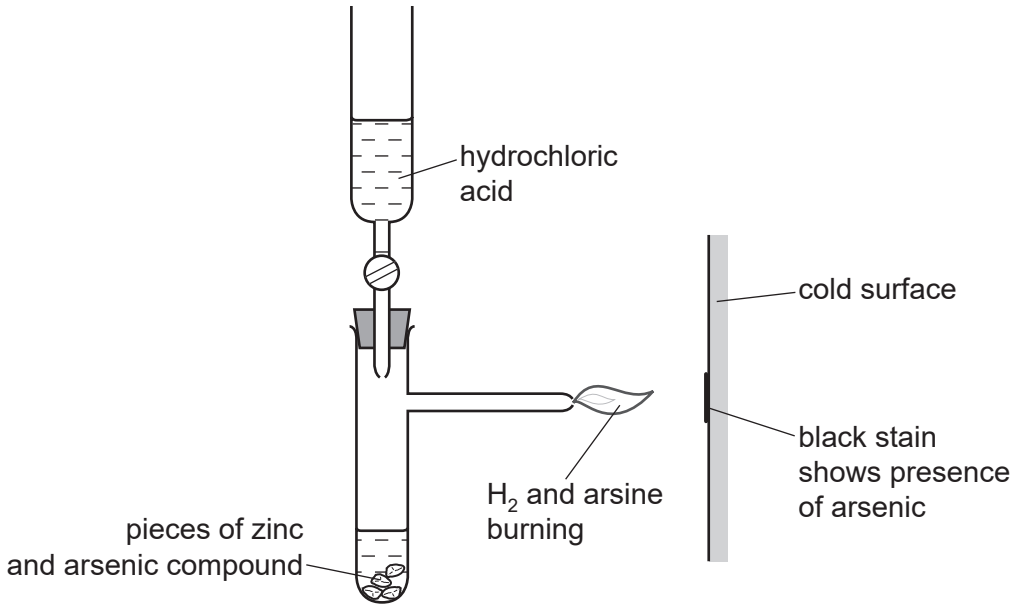
.....

..... [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).

.....Cu^{2+} + ...AsO_4^{3-} → .....

[2]

[Total: 14]

7 The structure of an
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]