

1 Tin is an element in Group IV.

(a) The position of tin in the reactivity series is:

zinc
iron
tin
copper

(i) For each of the following, decide if a reaction would occur. If there is a reaction, complete the equation, otherwise write 'no reaction'.



(ii) Name the **three** products formed when tin(II) nitrate is heated.

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

(b) Aqueous tin(II) sulfate is electrolysed using carbon electrodes. This electrolysis is similar to that of aqueous copper(II) sulfate using carbon electrodes.

(i) What is the product at the negative electrode (cathode)?
..... [1]

(ii) Write the equation for the reaction at the positive electrode (anode).
..... [2]

(iii) Name the acid formed in this electrolysis.
..... [1]

- (c) Steel articles can be plated with tin or zinc to prevent rusting. When the zinc layer is damaged exposing the underlying steel, it does not rust, but when the tin layer is broken the steel rusts. Explain.

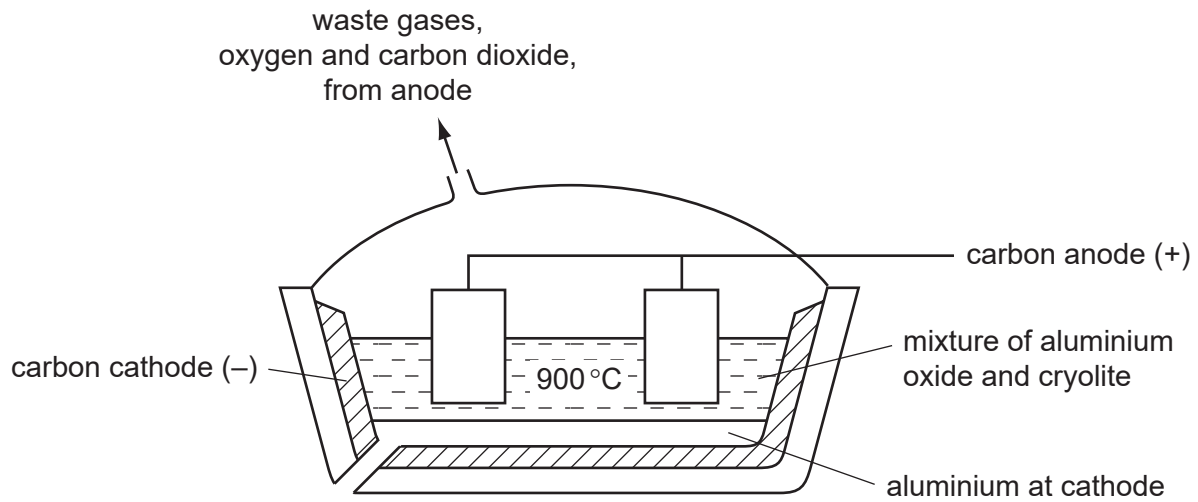
.....

.....

..... [4]

[Total: 14]

- 2 Aluminium is extracted by the electrolysis of a molten mixture of alumina, which is aluminium oxide, and cryolite.



(a) Alumina is obtained from the main ore of aluminium. Name this ore.
 [1]

(ii) Explain why it is necessary to use a mixture, alumina and cryolite, rather than just alumina.

 [2]

(iii) Copper can be extracted by the electrolysis of an aqueous solution. Suggest why the electrolysis of an aqueous solution cannot be used to extract aluminium.

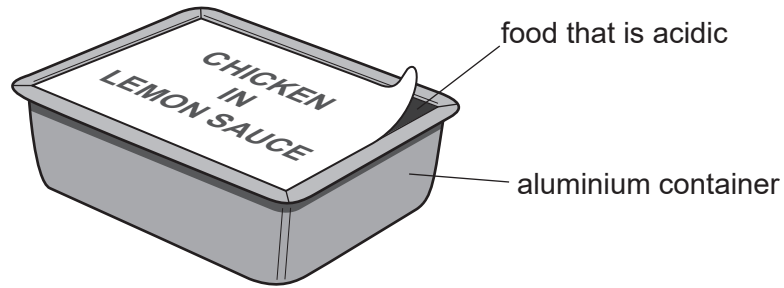
 [2]

(b) The ions which are involved in the electrolysis are Al^{3+} and O^{2-} . The products of this electrolysis are given on the diagram. Explain how they are formed. Use equations where appropriate.

 [4]

(c) The uses of a metal are determined by its properties.

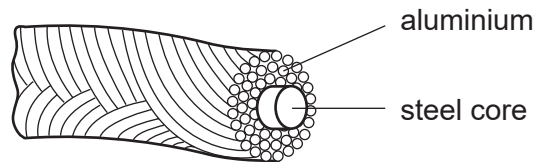
(i) Foods which are acidic can be supplied in aluminium containers.



Explain why the acid in the food does not react with the aluminium.

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

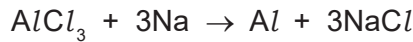
(ii) Explain why overhead electrical power cables are made from aluminium with a steel core.



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

[Total: 13]

3 Aluminium was first isolated in 1827 using sodium.

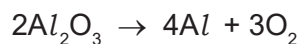


Aluminium, obtained by this method, was more expensive than gold.

(a) Suggest an explanation why aluminium was so expensive.

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

(b) The modern method for extracting aluminium is the electrolysis of a molten electrolyte, aluminium oxide dissolved in cryolite. The aluminium oxide decomposes.



Both electrodes are made of carbon.

(i) Give **two** reasons why the oxide is dissolved in cryolite.

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

(ii) Complete the ionic equation for the reaction at the anode.



(iii) Why do the carbon anodes need to be replaced frequently?

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

(c) The electrolysis of a molten electrolyte is one method of extracting a metal from its ore. Other methods are the electrolysis of an aqueous solution and the reduction of the oxide by carbon. Explain why these last two methods cannot be used to extract aluminium.

electrolysis of an aqueous solution

.....

using carbon

..... [2]

[Total: 8]

4 The electrolysis of concentrated aqueous sodium chloride, between inert electrodes, is used to make four important chemicals.

hydrogen
chlorine
sodium hydroxide
sodium chlorate(I)

(a) The ions present in the electrolyte are Na^+ , H^+ , Cl^- and OH^- .

(i) Hydrogen ions are discharged at the negative electrode (cathode).
Write an equation for this reaction.

..... [2]

(ii) The hydrogen ions are from the water.



Suggest an explanation why the concentration of hydroxide ions increases.

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

(iii) When a dilute solution of sodium chloride is used, chlorine is not formed at the positive electrode (anode), a different gas is produced. Name this gas.

..... [1]

(iv) State an example of an inert electrode.

..... [1]

(b) State a use of hydrogen.

..... [1]

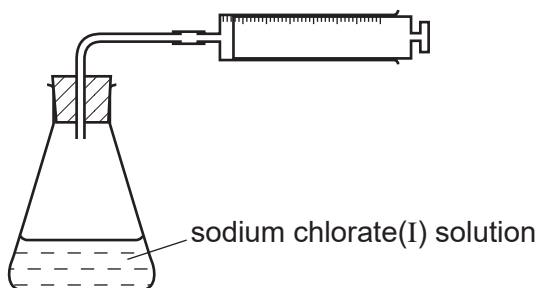
(ii) Why is chlorine used to treat the water supply?

..... [1]

- (c) Sodium chlorate(I) is made by the reaction between chlorine and sodium hydroxide. It is used as bleach but over time it decomposes.



The rate of decomposition can be studied using the apparatus shown below.



- (i) How could you measure the rate of decomposition of sodium chlorate(I)?

..... [1]

- (ii) Describe how you could show that the rate of decomposition of sodium chlorate(I) is a photochemical reaction.

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

[Total: 11]

5 The results of experiments on electrolysis using inert electrodes are given in the table.

Complete the table; the first line has been completed as an example.

electrolyte	change at negative electrode	change at positive electrode	change to electrolyte
molten lead(II) bromide	lead formed	bromine formed	used up
.....	potassium formed	iodine formed	used up
dilute aqueous sodium chloride
aqueous copper(II) sulfate
.....	hydrogen formed	bromine formed	potassium hydroxide formed

[Total: 8]

6 The electrolysis of concentrated aqueous sodium chloride produces three commercially important chemicals hydrogen, chlorine and sodium hydroxide.

(a) The ions present are $\text{Na}^+(\text{aq})$, $\text{H}^+(\text{aq})$, $\text{Cl}^-(\text{aq})$ and $\text{OH}^-(\text{aq})$.

(i) Complete the ionic equation for the reaction at the negative electrode (cathode).



(ii) Complete the ionic equation for the reaction at the positive electrode (anode).



(iii) Explain why the solution changes from sodium chloride to sodium hydroxide.

..... [1]

(b) Why does the water supply industry use chlorine?

..... [1]

(ii) Name an important chemical that is made from hydrogen.

..... [1]

(iii) How is sodium hydroxide used to make soap?

..... [2]

[Total: 7]