

1 Two of the main uses of zinc are for galvanising and for making alloys.

One of the main ores of zinc is zinc blende, ZnS. There are two stages in the extraction of zinc from this ore.

(a) **Stage 1** Zinc oxide is made from zinc blende.

Describe how this is done and write a word equation for the reaction.

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

(b) **Stage 2** Zinc oxide is reduced to zinc.

Write a word equation for the reduction of zinc oxide by coke.

..... [1]

(c) The zinc produced by this process is impure. It can be purified by electrolysis using a method which is similar to the purification of copper. Under the conditions used in the process, zinc is the product at the negative electrode (cathode).

Complete the following description of this purification.

The electrolyte is aqueous [1]

The negative electrode (cathode) is made of [1]

The positive electrode (anode) is impure zinc.

The equation for the reaction at the cathode is [1]

The equation for the reaction at the anode is [1]

Explain why the concentration of the electrolyte does **not** change.

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

(d) Brass is an alloy which contains zinc.

(i) Name the other metal in brass.

..... [1]

(ii) Suggest **two** reasons why an alloy such as brass is preferred to either of its constituent metals.

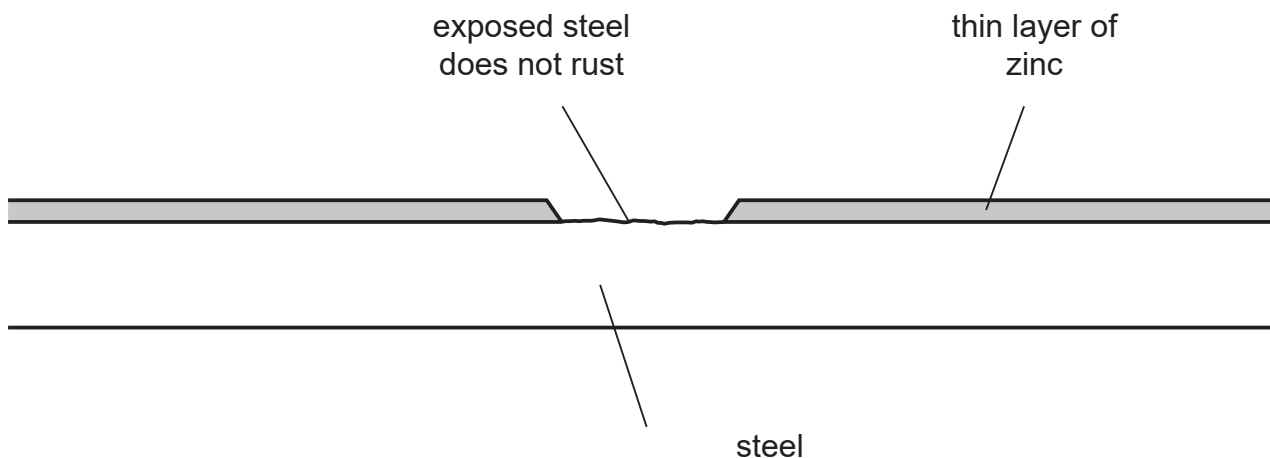
.....
..... [2]

(e) In an experiment to investigate the rate of rusting of steel, three pieces of steel were used. One piece of steel was completely coated with copper, one piece completely coated with zinc and the third piece was left uncoated. All three pieces were left exposed to the atmosphere.

(i) Explain why the uncoated piece started to rust.

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

(ii) The coating on both of the other two pieces was scratched, exposing the steel.



The piece of steel coated with zinc still did not rust but the copper-coated piece of steel rusted very rapidly.

Explain these observations in terms of the formation of ions and the transfer of electrons.

.....

.....

.....

.....

.....

..... [4]

[Total: 17]

2 Lithium bromide is an ionic compound. It can be electrolysed when it is molten or in aqueous solution. It cannot be electrolysed as a solid.

(a) Solid lithium bromide is a poor conductor of electricity. The ions cannot move to the electrodes, they are held in an ionic lattice by strong forces.

(i) Describe the motion of the ions in the solid state.

..... [1]

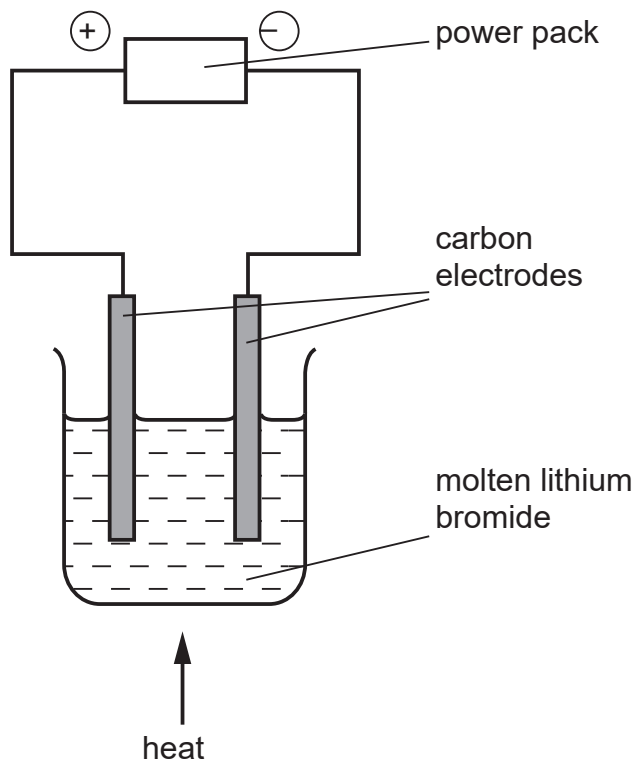
(ii) Define the term *ionic bonding*.

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

(iii) What is meant by the term *ionic lattice*?

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

(b) The diagram shows the electrolysis of molten lithium bromide.



(i) Mark on the diagram the direction of the electron flow. 9&;

(ii) Write an ionic equation for the reaction at the negative electrode (cathode).

..... [1]

(iii) Write an ionic equation for the reaction at the positive electrode (anode).

..... [2]

(iv) Which ion is oxidised? Explain your answer.

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

(c) When aqueous lithium bromide is electrolysed, a colourless gas is formed at the negative electrode and the solution becomes alkaline.

Explain these observations and include an equation in your explanation.

.....

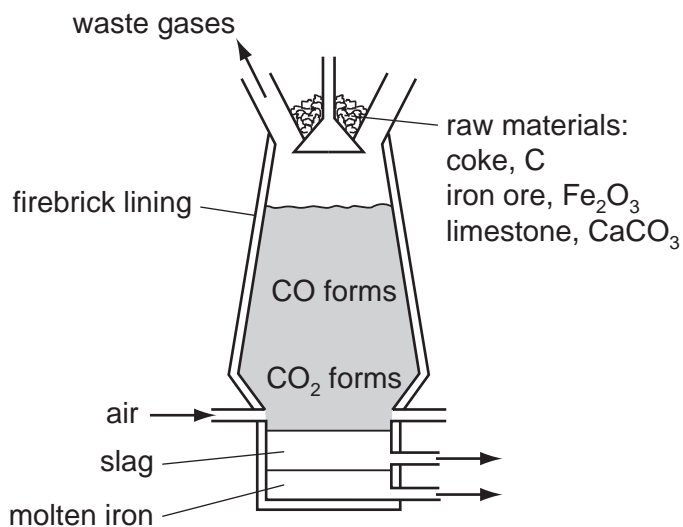
.....

.....

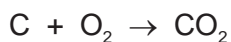
..... [3]

[Total: 14]

3 Iron is extracted from the ore hematite in the Blast Furnace.



(a) The coke reacts with the oxygen in the air to form carbon dioxide.



(i) Explain why carbon monoxide is formed higher in the Blast Furnace.

.....
 [2]

(ii) Write an equation for the reduction of hematite, Fe₂O₃, by carbon monoxide.

..... [2]

(b) Limestone decomposes to form two products, one of which is calcium oxide. Name the other product.

..... [1]

(ii) Calcium oxide reacts with silicon(IV) oxide, an acidic impurity in the iron ore, to form slag. Write an equation for this reaction.

..... [2]

(iii) Explain why the molten iron and the molten slag form two layers and why molten iron is the lower layer.

.....
 [2]

(iv) Suggest why the molten iron does **not** react with the air.

..... [1]

(c) Iron and steel

)

$2\text{Fe} + 3\text{O}_2 \rightarrow \text{Fe}_2\text{O}_3$, which is rust.

(i) Name the **two** substances which cause iron to rust.

..... [1]

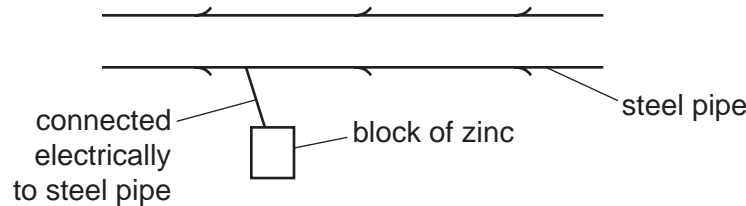
(ii) Explain why an aluminium article coated with aluminium oxide is protected from further corrosion but a steel article coated with rust continues to corrode.

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

(d) There are two electrochemical methods of rust prevention.

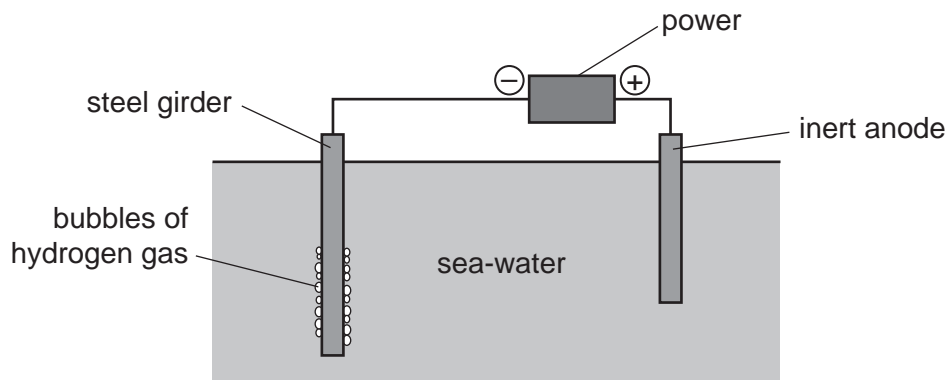
(i) The first method is sacrificial protection.

Explain why the steel article does not rust.



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

The second method is to make the steel article the cathode in a circuit for electrolysis.

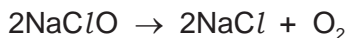


(ii) Mark on the diagram the direction of the electron flow. [1]

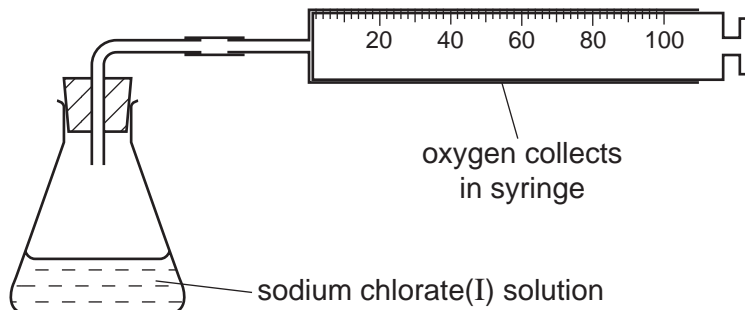
(iii) The steel girder does not rust because it is the cathode. Reduction takes place at the cathode. Give the equation for the reduction of hydrogen ions.

..... [2]

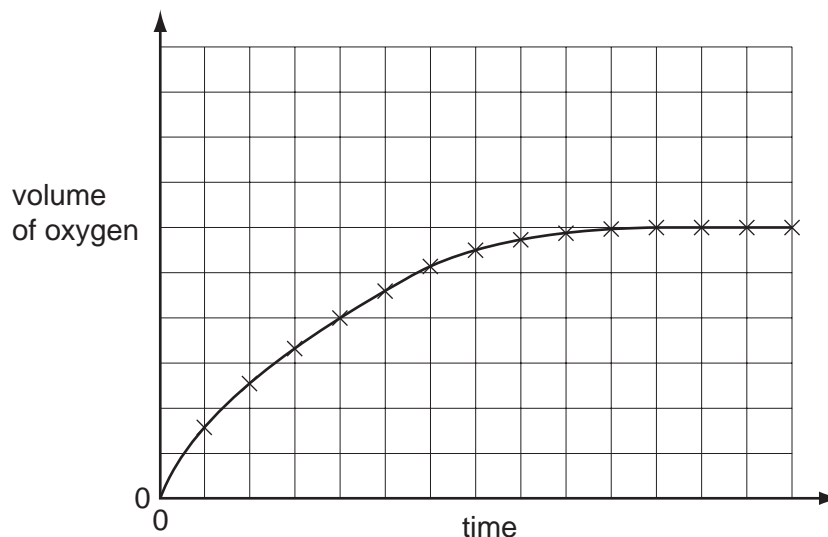
- 4 (a) Sodium chlorate(I) decomposes to form sodium chloride and oxygen. The rate of this reaction is very slow at room temperature provided the sodium chlorate(I) is stored in a dark bottle to prevent exposure to light.



The rate of this decomposition can be studied using the following experiment.



Sodium chlorate(I) is placed in the flask and 0.2 g of copper(II) oxide is added. This catalyses the decomposition of the sodium chlorate(I) and the volume of oxygen collected is measured every minute. The results are plotted to give a graph of the type shown below.



- (i) Explain why the gradient (slope) of this graph decreases with time.

.....
 [2]

- (ii) Cobalt(II) oxide is a more efficient catalyst for this reaction than copper(II) oxide. Sketch, on the grid, the graph for the reaction catalysed by cobalt(II) oxide. All other conditions were kept constant. [2]

(iii) What can you deduce from the comment that sodium chlorate(I) has to be shielded from light?

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

(iv) Explain, in terms of collisions between particles, why the initial gradient would be steeper if the experiment was repeated at a higher temperature.

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

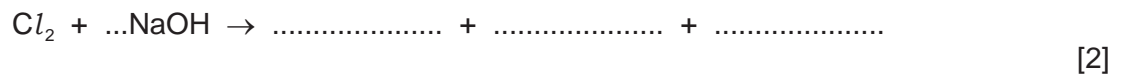
(b) The ions present in aqueous sodium chloride are $\text{Na}^+(\text{aq})$, $\text{Cl}^-(\text{aq})$, $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$.

The electrolysis of concentrated aqueous sodium chloride forms three products. They are hydrogen, chlorine and sodium hydroxide.

(i) Explain how these **three** products are formed. Give ionic equations for the reactions at the electrodes.

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

(ii) If the solution of the electrolyte is stirred, chlorine reacts with sodium hydroxide to form sodium chlorate(I), sodium chloride and water.
Write an equation for this reaction.



[Total: 14]