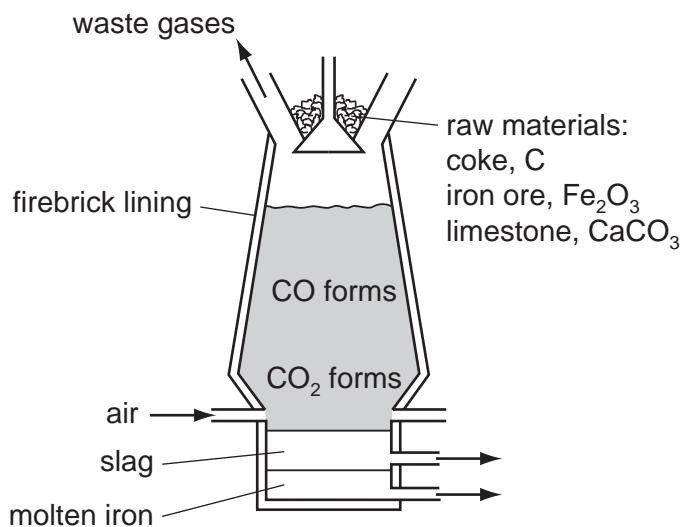
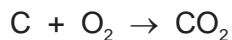


1 Iron is extracted from the ore hematite in the Blast Furnace.



(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, Fe_2O_3 , 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 3 2O , which is rust.

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

..... [1]

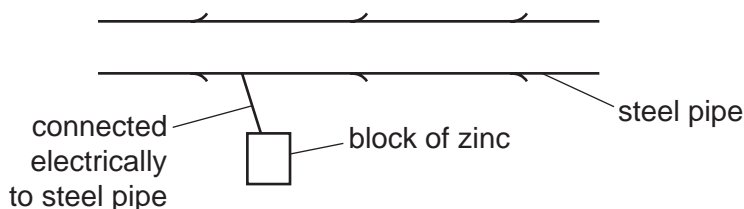
(ii) Explain why an aluminium article coated with aluminium oxide is protected from further corrosion but a steel article coated with rust continues to corrode.

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

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

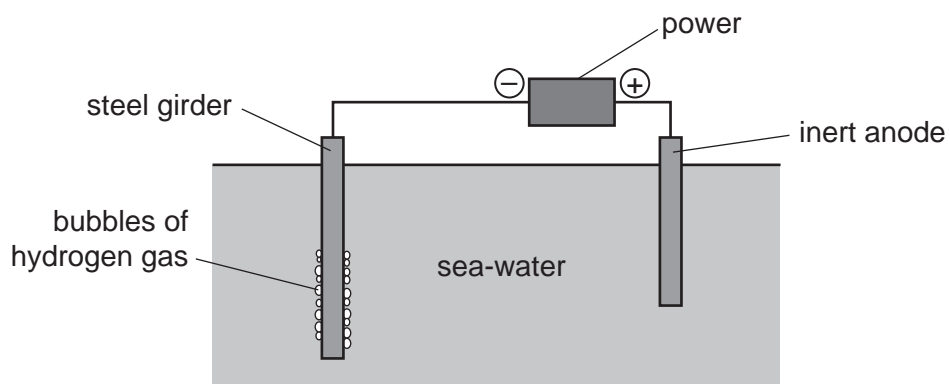
(i) The first method is sacrificial protection.

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]

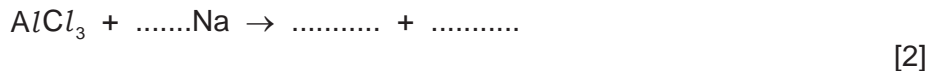
2 Aluminium is obtained by the reduction of aluminium ions to aluminium atoms.

(a) Write an ionic equation for the reduction of an aluminium ion to an aluminium atom.

..... [2]

(b) The original method of extracting aluminium involved the reduction of aluminium chloride using the reactive metal sodium. Aluminium obtained by this method was very expensive due to the high cost of extracting sodium from sodium chloride.

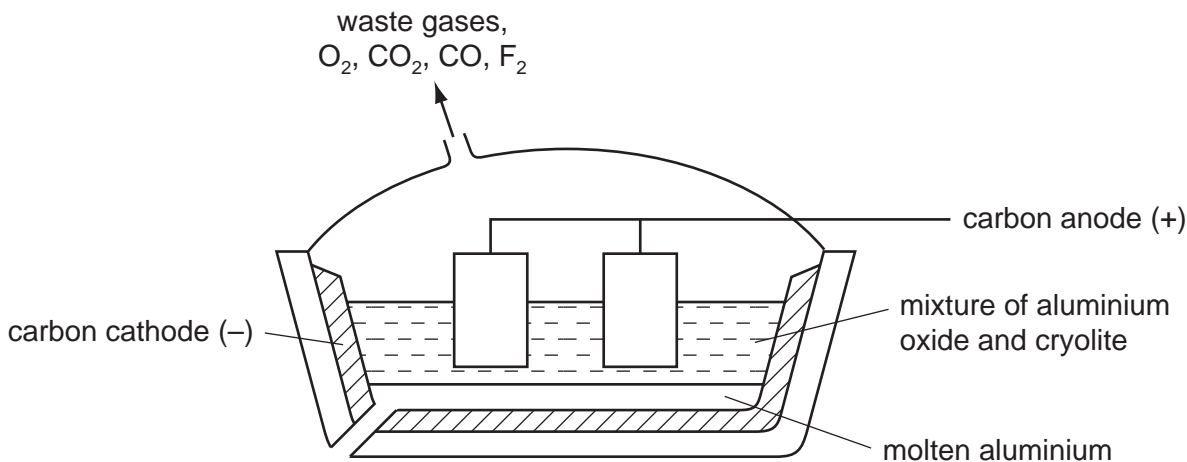
(i) Complete the equation for this reduction.



(ii) How can sodium metal be obtained from sodium chloride?

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

(c) In the modern method, aluminium is obtained by the electrolysis of aluminium oxide (alumina) dissolved in molten cryolite, Na_3AlF_6 .



(i) The major ore of aluminium is impure aluminium oxide. What is the name of this ore?

..... [1]

(ii) This ore is a mixture of aluminium oxide, which is amphoteric, and iron(III) oxide which is basic. Explain how these two oxides can be separated by the addition of aqueous sodium hydroxide.

.....
.....

(iii) Give **two** reasons why the electrolyte contains cryolite.

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

(iv) The mixture of gases evolved at the positive electrode includes:

- carbon dioxide
- carbon monoxide
- fluorine
- oxygen

Explain the presence of these gases in the gaseous mixture formed at the positive electrode. Include at least **one** equation in your explanation.

.....
.....
.....
.....
..... [5]

(d) A major use of aluminium is the manufacture of pots and pans. One reason for this is its resistance to corrosion.

(i) Explain why aluminium, a reactive metal, is resistant to corrosion.

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

(ii) Suggest **two** other reasons why aluminium is suitable for making pots and pans.

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

[Total: 19]

3 Rubidium and strontium are very reactive metals at the top of the reactivity series. Because their ions have different charges, their compounds behave differently when heated.

(a) The formulae of the ions of these two elements are Rb^+ and Sr^{2+} .
Explain why these metals, which are in different groups, form ions which have different charges.

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

(b) Strontium carbonate is similar to calcium carbonate. It is insoluble in water and it decomposes when heated. Rubidium carbonate is soluble in water and does not decompose when heated.

(i) Describe a method to prepare a pure sample of the insoluble salt, strontium carbonate, by precipitation.

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

(ii) Complete the equation for the decomposition of strontium carbonate.



(c) Metal nitrates decompose when heated.

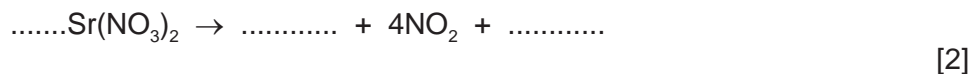
(i) Rubidium nitrate decomposes as follows:



What is the name of the compound RbNO_2 ?

..... [1]

(ii) The nitrates of most other metals decompose in a different way.
Complete the equation for the decomposition of strontium nitrate.



[Total: 10]

4 Zinc is obtained from the ore, zinc blende, ZnS.

(a) Describe the extraction of zinc from its ore, zinc blende. Include at least one balanced equation in your description.

.....
.....
.....
.....
..... [5]

(b) State **two** major uses of zinc.

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

[Total: 7]

5 Iron from a blast furnace contains about 5% of the impurities – carbon, silicon, phosphorus and sulfur. Most of this impure iron is used to make steels, such as mild steel, and a very small percentage is used to make pure iron.

(a) Calcium oxide and oxygen are used to remove the impurities from the iron produced in the blast furnace.

(i) State how these chemicals are manufactured.

calcium oxide

oxygen

[3]

(ii) Describe how these two chemicals remove the four impurities. Include at least one equation in your answer.

.....
.....
.....
.....
.....
.....
..... [5]

(b) Describe the structure of a typical metal such as iron. You may include a diagram.

.....
.....

[2]

(ii) Explain why pure iron is malleable.

.....
.....

[2]

(iii) Mild steel is an alloy of iron and carbon.
Suggest why mild steel is harder than pure iron.

.....
.....
.....

[2]

[Total: 14]