

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]

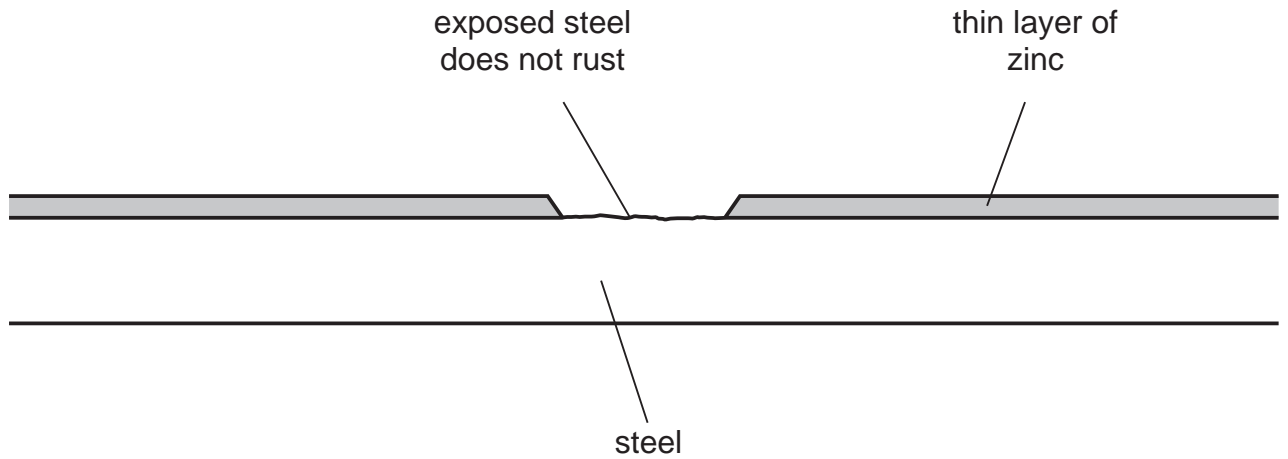
**(e)** In an experiment to investigate the rate of rusting of steel, three pieces of steel were used. One piece of steel was completely coated with copper, one piece completely coated with zinc and the third piece was left uncoated. All three pieces were left exposed to the atmosphere.

**(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.

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..... [4]

[Total: 17]

2 Iron is extracted from its ore, hematite, in a blast furnace.

Substances added to the furnace are:

- iron ore, hematite, containing impurities such as silica,  $\text{SiO}_2$
- air
- coke, C
- limestone,  $\text{CaCO}_3$

Substances formed in the blast furnace are:

- molten iron
- molten slag
- waste gases such as carbon dioxide

(a) State the **two** functions of the coke used in the blast furnace.

.....  
.....

[2]

(b) Write an equation for the conversion of hematite,  $\text{Fe}_2\text{O}_3$ , to iron.

.....

[2]

**(c)** Explain how the silica impurity is removed and separated from the molten iron.

.....

.....

.....

..... [3]

**(d)** The molten iron from the furnace is impure.  
It contains impurities which include the element carbon.

Explain how the carbon is removed. Include an equation in your answer.

.....

.....

..... [3]

[Total: 10]

3 A reactivity series of metals is given below.

metal name	symbol
sodium lithium	Na
magnesium	Li
zinc	Mg
manganese	Zn
iron copper	Mn
rhodium	Fe
	Cu
	Rh

most reactive

↓

least reactive

(a) Which **two** metals will react most vigorously with cold water?

.....[1].

(b) Which **two** metals will not react with dilute hydrochloric acid?

.....[1].

(c) Deduce the formula of iron(III) sulfate.

..... [1]

(d) What is the formula of a magnesium ion?

..... [1]

(e) Describe a test-tube experiment which will show that manganese is more reactive than copper.

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



(f) Manganese is a typical transition metal.

Predict **three** physical and **two** chemical properties of this metal. physical properties

.....

.....

.....

chemical properties

.....

.....

[5]

[Total: 12]

4 Iron from the Blast Furnace is impure. It contains about 5% of impurities, mainly carbon, sulfur, silicon and phosphorus, which have to be removed when this iron is converted into steel.

(a) Explain how the addition of oxygen and calcium oxide removes these impurities. Include an equation for a reaction of oxygen and a word equation for a reaction of calcium oxide in this process.

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

[5]

(b) Mild steel is the most common form of steel. Mild steel contains a maximum of 0.3% of carbon. High carbon steel contains 2% of carbon. It is less malleable and much harder than mild steel.

(i) Give a use of mild steel.

..... [1]

(ii) Suggest a use of high carbon steel.

..... [1]

(iii) Explain why metals are malleable.

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

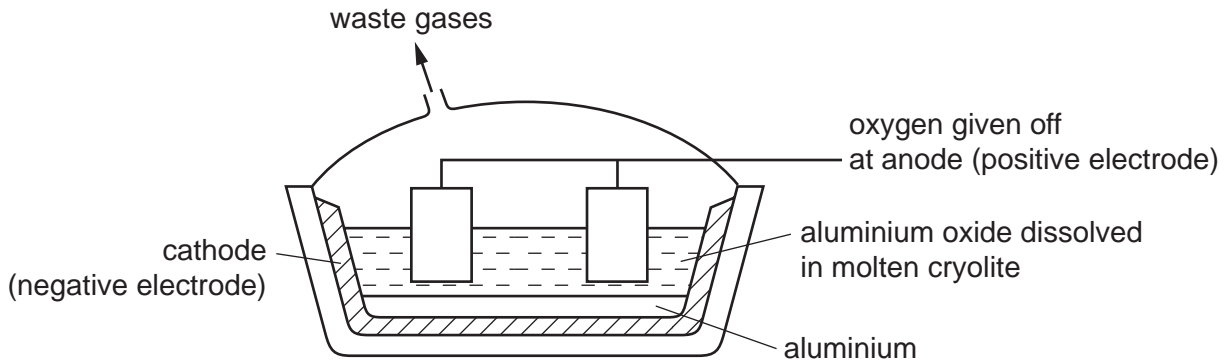
(iv) Suggest an explanation why high carbon steel is less malleable and harder than mild steel.

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

[Total: 12]

5 Aluminium and iron are extracted from their ores by different methods.

Aluminium is extracted from its purified oxide ore by electrolysis.



(a) What is the name of the ore of aluminium which consists mainly of aluminium oxide?

..... [1]

(b) The electrodes are both made of the same substance.

Name this substance.

..... [1]

(c) Aluminium oxide is dissolved in molten cryolite before it is electrolysed.

Give **two** reasons why aluminium oxide dissolved in molten cryolite is electrolysed rather than molten aluminium oxide alone.

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

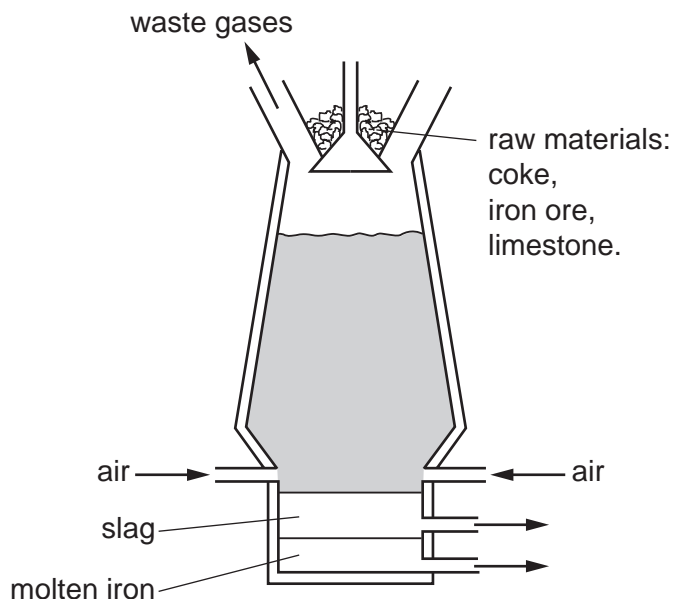
(d) Write the **ionic** equations for the reactions at the electrodes in this electrolysis.

anode (positive electrode) .....

cathode (negative electrode) .....

[2]

(e) Iron is extracted from its oxide ore by reduction using carbon in a blast furnace.



(i) Place the elements aluminium, carbon and iron in order of reactivity with the **least** reactive element first.

..... [1]

(ii) Use your answer to (e)(i) to explain why iron is extracted by reduction using carbon but aluminium is not.

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

(f) What is the name of the ore of iron which consists mainly of iron(III) oxide?

..... [1]

(g) Write balanced equations for the reactions occurring in the blast furnace which involve

(i) the complete combustion of coke (carbon),

..... [1]

(ii) the production of carbon monoxide from carbon dioxide,

..... [1]

(iii) the reduction of iron(III) oxide,

..... [1]

(iv) the formation of slag.

..... [1]