

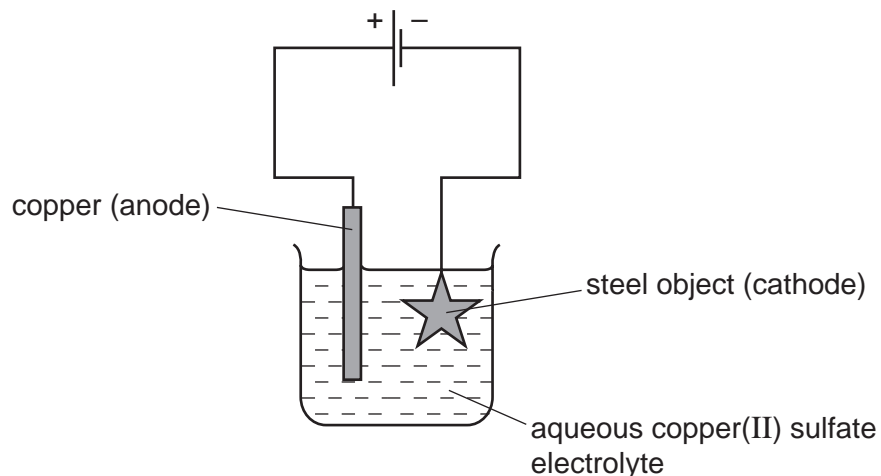
1 Electroplating steel objects with silver involves a three-step process.

**step 1** A coating of copper is applied to the object.

**step 2** A coating of nickel is applied to the object.

**step 3** The coating of silver is applied to the object.

(a) A diagram of the apparatus used for **step 1** is shown.



(i) The chemical process taking place on the surface of the object is



Explain whether this process is oxidation or reduction.

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

(ii) Explain why the concentration of copper ions in the electrolyte remains constant throughout **step 1**.

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

(b) Give **two** changes which would be needed in order to coat nickel onto the object in **step 2**.

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

(c) Copper, nickel and silver are transition elements.  
Typical physical properties of transition elements are a high density and a high melting point.

Give **three** different properties of transition metals which are not typical of other metals.

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

[Total: 8]

2 Lead is an excellent roofing material. It is malleable and resistant to corrosion. Lead rapidly becomes coated with basic lead carbonate which protects it from further corrosion.

(a) Lead has a typical metallic structure which is a lattice of lead ions surrounded by a 'sea' of mobile electrons. This structure is held together by attractive forces called a metallic bond.

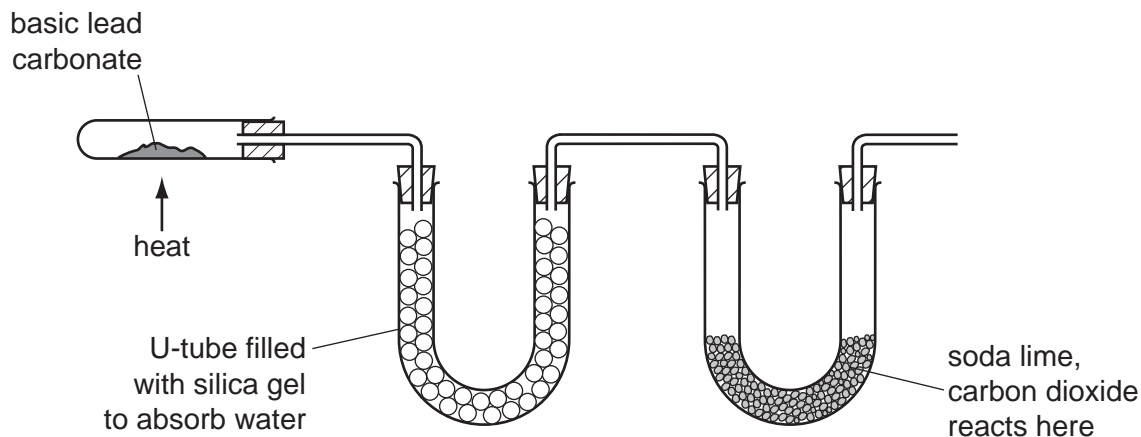
(i) Explain why there are attractive forces in a metallic structure.

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

(ii) Explain why a metal, such as lead, is malleable.

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

(b) Basic lead(II) carbonate is heated in the apparatus shown below. Water and carbon dioxide are produced.



(i) Silica gel absorbs water. Silica gel often contains anhydrous cobalt(II) chloride. When this absorbs water it changes from blue to pink. Suggest a reason.

..... [1]

(ii) Soda lime is a mixture of sodium hydroxide and calcium oxide. Why do these two substances react with carbon dioxide?

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

(iii) Name **two** substances formed when soda lime reacts with carbon dioxide.

..... [2]

- (c) Basic lead(II) carbonate has a formula of the type  $x\text{PbCO}_3 \cdot y\text{Pb(OH)}_2$  where x and y are whole numbers.  
Determine x and y from the following information.



When heated, the basic lead(II) carbonate gave 2.112 g of carbon dioxide and 0.432 g of water.

Mass of one mole of  $\text{CO}_2 = 44 \text{ g}$

Mass of one mole of  $\text{H}_2\text{O} = 18 \text{ g}$

Number of moles of  $\text{CO}_2$  formed = ..... [1]

Number of moles of  $\text{H}_2\text{O}$  formed = ..... [1]

x = ..... and y = .....

Formula of basic lead(II) carbonate is ..... [1]

[Total: 12]

3 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.

.....

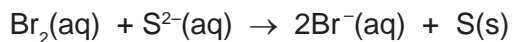
.....

..... [4]

[Total: 14]

4 The following are examples of redox reactions.

(a) Bromine water was added to aqueous sodium sulfide.



(i) Describe what you would observe when this reaction occurs.

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

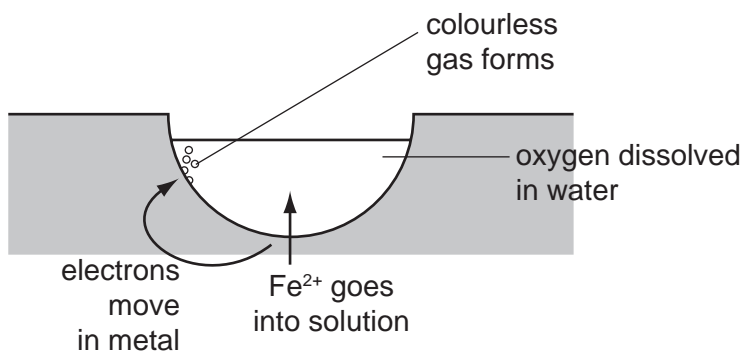
(ii) Write a symbol equation for this reaction.

..... [1]

(iii) Explain, in terms of electron transfer, why bromine is the oxidant (oxidising agent) in this reaction.

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

(b) Iron and steel in the presence of water and oxygen form rust.



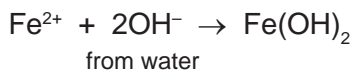
The reactions involved are:

**reaction 1**



The electrons move through the iron on to the surface where a colourless gas forms.

**reaction 2**



**reaction 3**



The water evaporates to leave rust.

(i) What type of reaction is **reaction 1**? ..... [1]

(ii) Deduce the name of the colourless gas mentioned in **reaction 1**.  
..... [1]

(iii) What is the name of the iron compound formed in **reaction 2**?  
..... [1]

(iv) Balance the equation for **reaction 3**.  
 $.....\text{Fe}(\text{OH})_2 + \text{O}_2 + ..... \text{H}_2\text{O} \rightarrow ..... \text{Fe}(\text{OH})_3$  [1]

(v) Explain why the change  $\text{Fe}(\text{OH})_2$  to  $\text{Fe}(\text{OH})_3$  is oxidation.  
.....  
..... [1]

(vi) Explain why iron in electrical contact with a piece of zinc does not rust.  
.....  
.....  
..... [3]

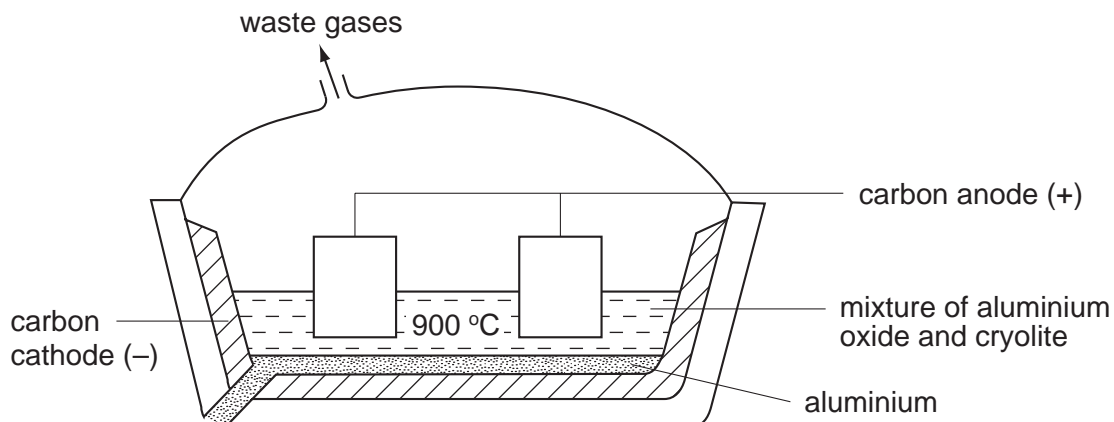
[Total: 13]



5 The position of aluminium in the reactivity series of metals is shown below.

magnesium  
aluminium  
zinc  
copper

(a) Aluminium is extracted by the electrolysis of its molten oxide.



(i) Name the main ore of aluminium.

..... [1]

(ii) Why does the molten electrolyte contain cryolite?

..... [1]

(iii) Oxygen is produced at the positive electrode (anode). Name another gas which is given off at this electrode.

..... [1]

(b) Aluminium reacts very slowly with aqueous copper(II) sulphate.



(i) Which of the two metals has the greater tendency to form ions?

..... [1]

(ii) Describe what you would see when this reaction occurs.

..... [1]

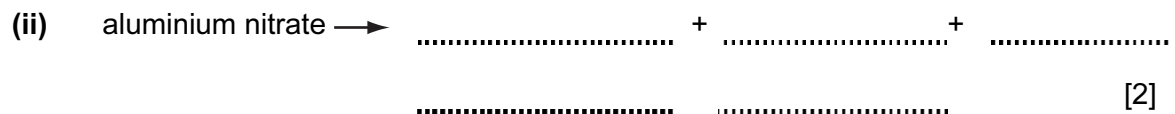
(iii) Explain why aluminium reacts so slowly.

(c) Complete the following table by writing "reaction" or "no reaction" in the spaces provided.

oxide	type of oxide	reaction with acid	reaction with alkali
magnesium		.....	.....
aluminium	am	.....	.....

[2]

(d) Predict the equations for the decomposition of the following aluminium compounds.





(c) The major ore of strontium is its carbonate,  $\text{SrCO}_3$ . Strontium is extracted by the electrolysis of its molten chloride.

(i) Name the reagent that will react with the carbonate to form the chloride.

..... [1]

(ii) The electrolysis of molten strontium chloride produces strontium metal and chlorine. Write ionic equations for the reactions at the electrodes.

negative electrode (cathode) .....

positive electrode (anode) ..... [2]

(iii) One of the products of the electrolysis of concentrated aqueous strontium chloride is chlorine. Name the other two.

..... [2]

(d) Both metals react with water.

(i) Write a word equation for the reaction of zinc and water and state the reaction conditions.

word equation ..... [1]

conditions ..... [2]

(ii) Write an equation for the reaction of strontium with water and give the reaction condition.

equation ..... [2]

condition ..... [1]