

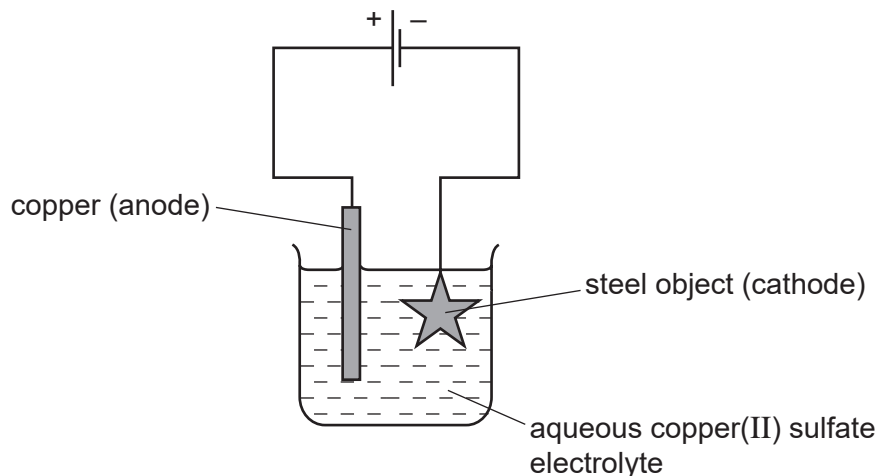
1 Electroplating steel objects with silver involves a three-step process.

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

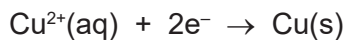
**step 2** A coating of nickel is applied to the object.

**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 Chemical reactions are always accompanied by an energy change.

(a) Aluminium is extracted by the electrolysis of a molten mixture which contains aluminium oxide,  $Al_2O_3$ . This decomposes to form aluminium at the negative electrode and oxygen at the positive electrode.

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

..... [2]

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



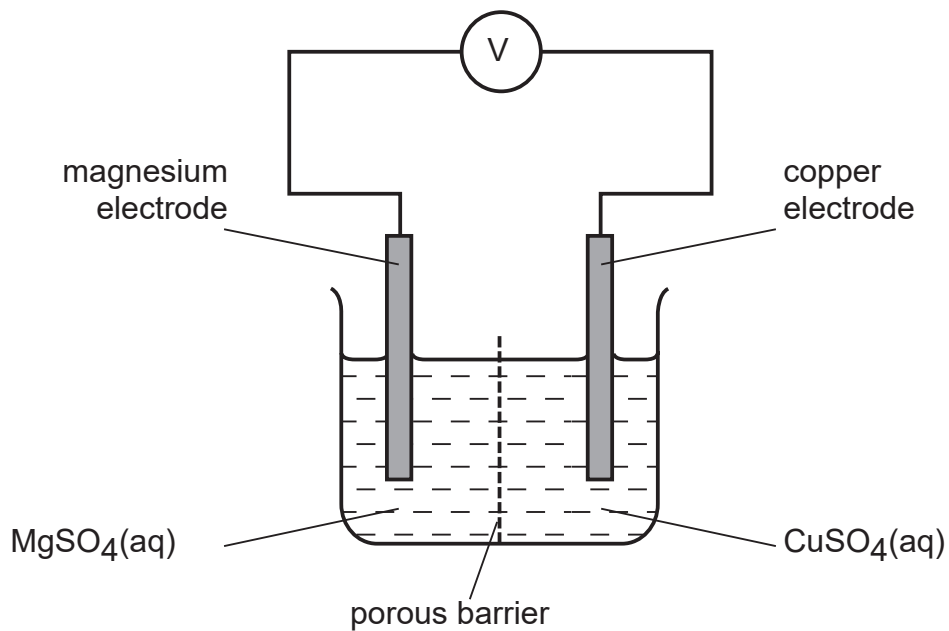
[2]

(iii) Is the reaction exothermic or endothermic? Explain your answer.

.....

..... [1].

(b) The cell shown below can be used to determine the order of reactivity of metals.



(i) Is the reaction in the cell exothermic or endothermic? Explain your answer.

.....

..... [1]

(ii) Explain why the mass of the magnesium electrode decreases and the mass of the copper electrode increases.

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

(iii) How could you use this cell to determine which is the more reactive metal, magnesium or manganese?

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

(c) The combustion of propane,  $C_3H_8$ , is exothermic.

Give an equation for the complete combustion of propane.

..... [2]

(d) Photosynthesis is an unusual endothermic reaction.

(i) Where does the energy for photosynthesis come from?

..... [1]

(ii) Give the word equation for photosynthesis.

..... [1]

[Total: 14]

3 Zinc is an important metal. Its uses include making alloys and the construction of dry cells (batteries).

(a) Name an alloy which contains zinc. What is the other metal in this alloy?

name of alloy .....

other metal in alloy .....

[2]

(b) The main ore of zinc is zinc blende, ZnS.

(i) The ore is heated in the presence of air to form zinc oxide and sulfur dioxide.  
Write the equation for this reaction.

..... [2]

(ii) Give a major use of sulfur dioxide.

..... [1]

(c) Zinc can be obtained from zinc oxide in a two step process. Aqueous zinc sulfate is made from zinc oxide and then this solution is electrolysed with inert electrodes. The electrolysis is similar to that of copper(II) sulfate with inert electrodes.

(i) Name the reagent which will react with zinc oxide to form zinc sulfate.

..... [1]

(ii) Complete the following for the electrolysis of aqueous zinc sulfate.

Write the equation for the reaction at the negative electrode.

.....

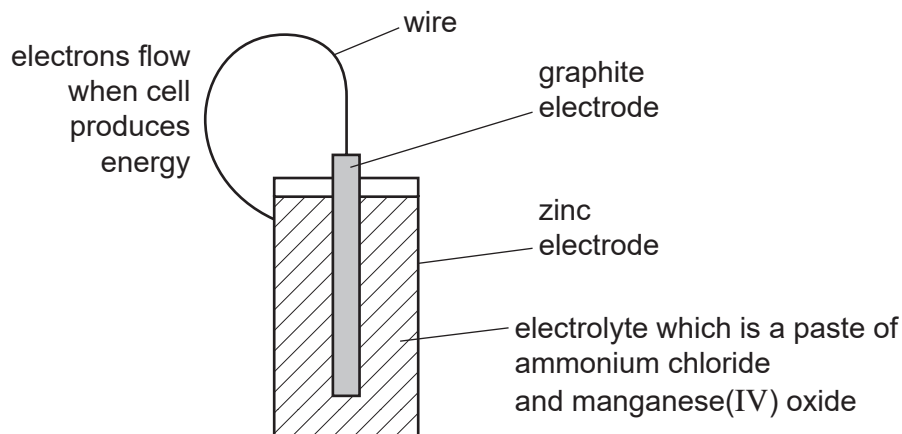
Name the product at the positive electrode.

.....

The electrolyte changes from zinc sulfate to .....

[3]

- (d) A dry cell (battery) has a central rod, usually made of graphite. This is the positive electrode which is surrounded by the electrolyte, typically a paste of ammonium chloride and manganese(IV) oxide, all of which are in a zinc container which is the negative electrode.



- (i) Draw an arrow on the diagram to indicate the direction of electron flow. [1]

- (ii) Suggest why the electrolyte is a paste.

..... [1]

- (iii) The following changes occur in a dry cell.  
For each change, decide if it is oxidation or reduction and give a reason for your choice.

Zn to  $Zn^{2+}$

.....

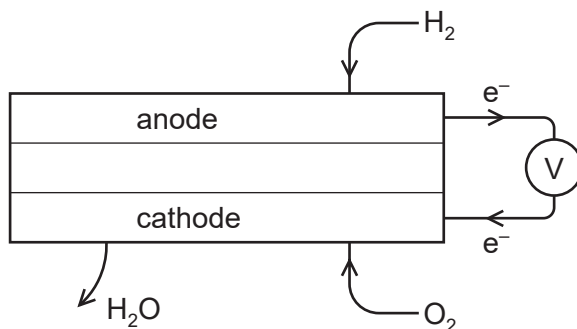
manganese(IV) oxide to manganese(III) oxide

.....

[2]

[Total: 13]

- 4 A fuel cell produces electrical energy by the oxidation of a fuel by oxygen. The fuel is usually hydrogen but methane and methanol are two other fuels which may be used. A diagram of a hydrogen fuel cell is given below.



- (a) When the fuel is hydrogen, the only product is water. What additional product would be formed if methane was used?

..... [1]

- (b) Write the equation for the chemical reaction that takes place in a hydrogen fuel cell.

..... [1]

- (c) At which electrode does oxidation occur? Explain your choice.

..... [1]

- (ii) Write an ionic equation for the reaction at this electrode.

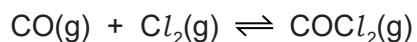
..... [2]

- (d) Fuel cells are used to propel cars. Give **two** advantages of a fuel cell over a gasoline-fuelled engine.

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

[Total: 7]

5 Carbonyl chloride is made from carbon monoxide and chlorine.

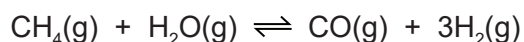


(a) Two methods of preparing carbon monoxide are from methane and oxygen, and from methane and steam.

(i) The reaction between methane and oxygen can also form carbon dioxide. How can carbon monoxide be made instead of carbon dioxide?

..... [1]

(ii) The following reaction is used to make carbon monoxide and hydrogen. The reaction is carried out at 1100 °C and normal pressure.



The reaction is reversible and comes to equilibrium. Suggest why a high temperature is used.

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

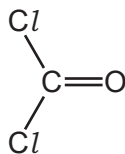
(iii) What is the disadvantage of using a high pressure for the reaction given in (a)(ii)?

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

(b) Chlorine is made by the electrolysis of concentrated aqueous sodium chloride. Describe this electrolysis. Write ionic equations for the reactions at the electrodes and name the sodium compound formed.

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

(c) The structural formula of carbonyl chloride is given below.



Draw a diagram showing the arrangement of the valency electrons around the atoms in one molecule of this covalent compound.

Use o to represent an electron from an oxygen atom.

Use x to represent an electron from a chlorine atom.

Use ● to represent an electron from a carbon atom.

[3]

[Total: 13]

6 Aluminium is obtained from purified alumina,  $Al_2O_3$ , by electrolysis.

(a) Alumina is obtained from the main ore of aluminium.  
State the name of this ore.

..... [1]

(b) Describe the extraction of aluminium from alumina. Include the electrolyte, the electrodes and the reactions at the electrodes.

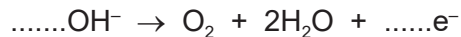
.....  
.....  
.....  
.....  
.....  
.....  
..... [6]

(c) Aluminium is resistant to corrosion. It is protected by an oxide layer on its surface.  
The thickness of this oxide layer can be increased by anodising.

(i) State a use of aluminium due to its resistance to corrosion.

..... [1]

(ii) Anodising is an electrolytic process. Dilute sulfuric acid is electrolysed with an aluminium object as the anode. The thickness of the oxide layer is increased. Complete the equations for the reactions at the aluminium anode.



[Total: 12]