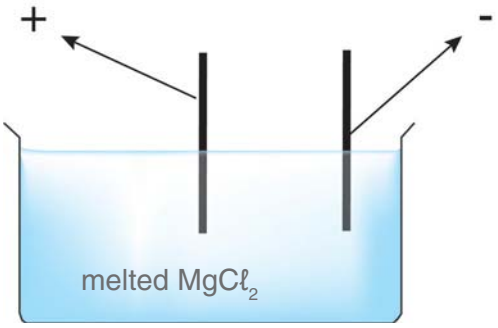
The extraction of aluminium leads to various environmental and economic problems:

- Change in landscape, so the environment is not attractive any more.
- Noise pollution
- Air pollution: the release of carbon dioxide (greenhouse gas), carbon monoxide (toxic) and toxic fluorine and fluorine compounds.
- Pollution during the generation of electrical energy.
- Red mud waste is dumped and harmful alkalis leach, polluting the ground water.

Exercise 29

Date:

1 Magnesium metal is obtained from the electrolysis of melted magnesium chloride. A simple diagram of the electrolytic cell is shown:



1.1 Identify the charges on the cathode and anode.

_____

_____

1.2 Write down the half-reaction that occurs at each electrode respectively.
Anode

_____

Cathode

_____

1.3 What is the name and formula of the electrolyte in the cell?

_____

2 Impure copper is electrolytically purified in a cell in which an acidified copper(II) sulphate solution serves as an electrolyte.

2.1 Define electrolysis.

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_____

_____

2.2 Draw a simple, labelled sketch representing an electrolytic cell that can be set up in a school laboratory to simulate the industrial purification of a piece of impure copper.

2.3 Write down the half-reaction that takes place at the anode.

_____

2.4 Write down the half-reaction that takes place at the cathode.

_____

2.5 Why does the concentration of the copper(II) ions remain constant?

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2.6 Assume that the impure piece of copper contains both platinum and silver. Refer to the relative strength of the reducing agents to explain why these two metals do not form ions during the purification process.

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3 A medal, which is made of nickle, is electroplated with silver.

3.1 Recommend a suitable electrolyte to be used in the electrolytic cell.

_____

3.2 Which metal should be used as the anode in the cell?

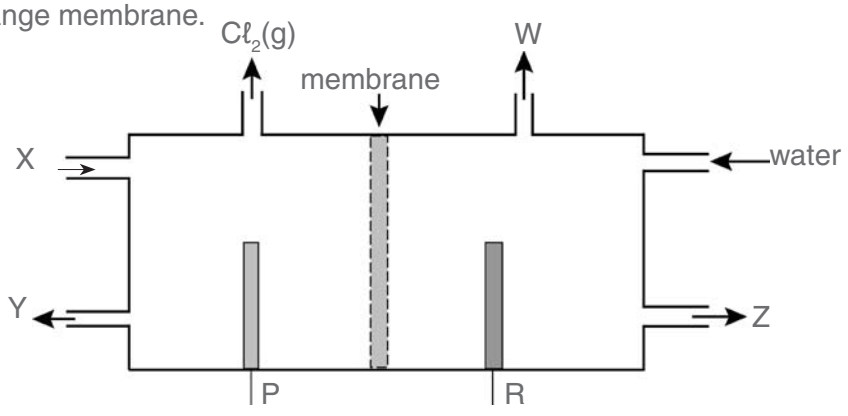
_____

3.3 Explain, with reference to oxidation and/or reduction, why the mass of the anode decreases during the reaction.

3.4 Write down the half-reaction that takes place at the piece of nickle.

3.5 Plastic objects are sometimes covered with a metal through electroplating. Plastic is not an electrical conductor. Explain how plastic should be prepared to ensure that it can be electroplated.

4 Consider the following representation of an electrolytic cell that can be used for the preparation of chlorine gas and hydrogen. The membrane that seperates the two half-cell compartments is a cation-exchange membrane.



4.1 Write down the chemical name, chemical formula and common name for the solution marked X.

4.2 What is the difference between solutions X and Y?

4.3 Write down the chemical name, chemical formula and common name for the solution marked Z.

_____

4.4 Consider electrode P.

4.4.1 Is P the anode or the cathode? Should it be connected to the negative or positive terminal of the energy source?

_____

4.4.2 Write down the half-reaction that occurs at P.

_____

4.4.3 Hydroxide ions, $OH^-(aq)$, sometimes also react at electrode P. Which gas will be produced at P due to this reaction?

_____

4.4.4 Write down a half-reaction to show how this gas is formed through the oxidation of the hydroxide ion.

_____

4.5 Consider the gas that is released at W.

4.5.1 Write down the name of the gas that is released at W.

_____

4.5.2 Write down a half-reaction to show how this gas forms.

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4.6 Use the relative strength of oxidising agents that are present in the brine to explain why sodium metal is NOT one of the products in this process.

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5 Aluminium is extracted from bauxite through an electrolytic process.

5.1 Why can aluminium not be recovered from bauxite in a furnace, as is the case with iron?

5.2 Although aluminium is the metal that is most abundant in the lithosphere, it is very expensive. Provide an explanation for this.

5.3 At which electrode does aluminium form during electrolysis?

5.4 Write down the half-reaction that leads to the formation of aluminium at the electrode, as referred to in Question 5.3.

5.5 Write down the name and the formula of the product that forms at the positive electrode.

5.6 Is the positive electrode the anode or the cathode? Motivate your answer.

5.7 What are the electrodes in an aluminium oxide electrolysis tank made of?

5.8 Give two reasons why this element is used as the electrode.