Cambridge (CIE) IGCSE Chemistry

Your notes

Applications of Electrolysis

Contents

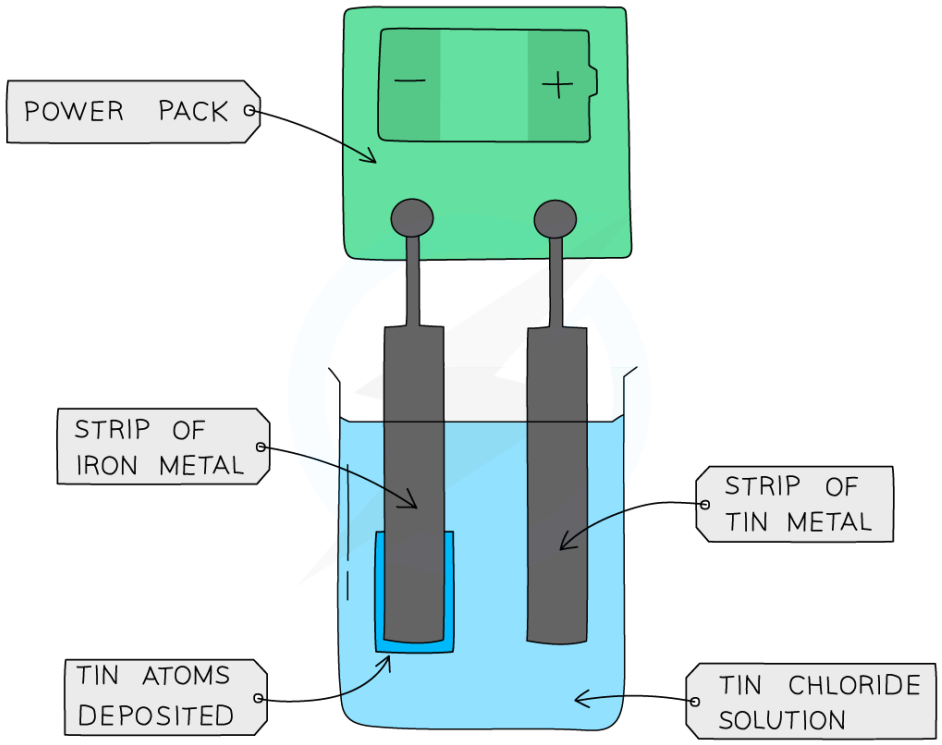
Your notes

Electroplating

What is electroplating?

- Electroplating is a process where the surface of one metal is **coated** with a layer of a different metal
- The **cathode / negative electrode** is the **object** to be electroplated
- The **anode / positive electrode** is made from the **pure** metal that will be plated onto the object
- The **electrolyte** is an **aqueous solution** of a soluble salt of the pure metal at the anode

Electroplating a strip of iron with tin



A piece of iron being electroplated with tin. The electrolyte is tin(II) chloride, a water-soluble salt of tin

- At the anode:
  - Tin atoms lose electrons to form tin ions in solution

- The loss of electrons is oxidation
- At the cathode:
  - Tin ions gain electrons to form tin atoms
  - The gain of electrons is reduction
  - The tin atoms are deposited on the strip of iron metal, coating it with a layer of tin

Examiner Tips and Tricks

Extended Tier students may be asked to write the ionic half equations for the reaction at each electrode. For the example above, these would be:

At the anode: $Sn(s) \rightarrow Sn^{2+}(aq) + 2e^-$

At the cathode: $Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$

What is electroplating used for?

- Electroplating is done to make metals more **resistant** to corrosion or damage
  - e.g. chromium and nickel plating
  - e.g. galvanising - zinc plating / coating, typically done to iron and steel
- It is also done to **improve the appearance** of metals,
  - e.g. coating cutlery and jewellery with silver

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Hydrogen fuel cells

- A fuel is a substance which releases energy when burned
- Hydrogen is used as a fuel in rocket engines and in fuel cells to power some cars
- A fuel cell is an electrochemical cell in which a fuel **donates** electrons at one electrode and oxygen **gains** electrons at the other electrode
  - $H_2 \rightarrow 2H^+ + 2e^-$
  - $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$
- The **hydrogen-oxygen** fuel cell produces electricity by combining both elements, releasing energy and water
- The overall equation for the reaction within a hydrogen fuel cell is:

hydrogen + oxygen → water

$$\mathbf{2H_2 + O_2 \rightarrow 2H_2O}$$

- The diagram below shows the setup of a hydrogen fuel cell
  - The air entering provides the oxygen
  - The fuel entering is hydrogen
  - The only chemical product made is **water**

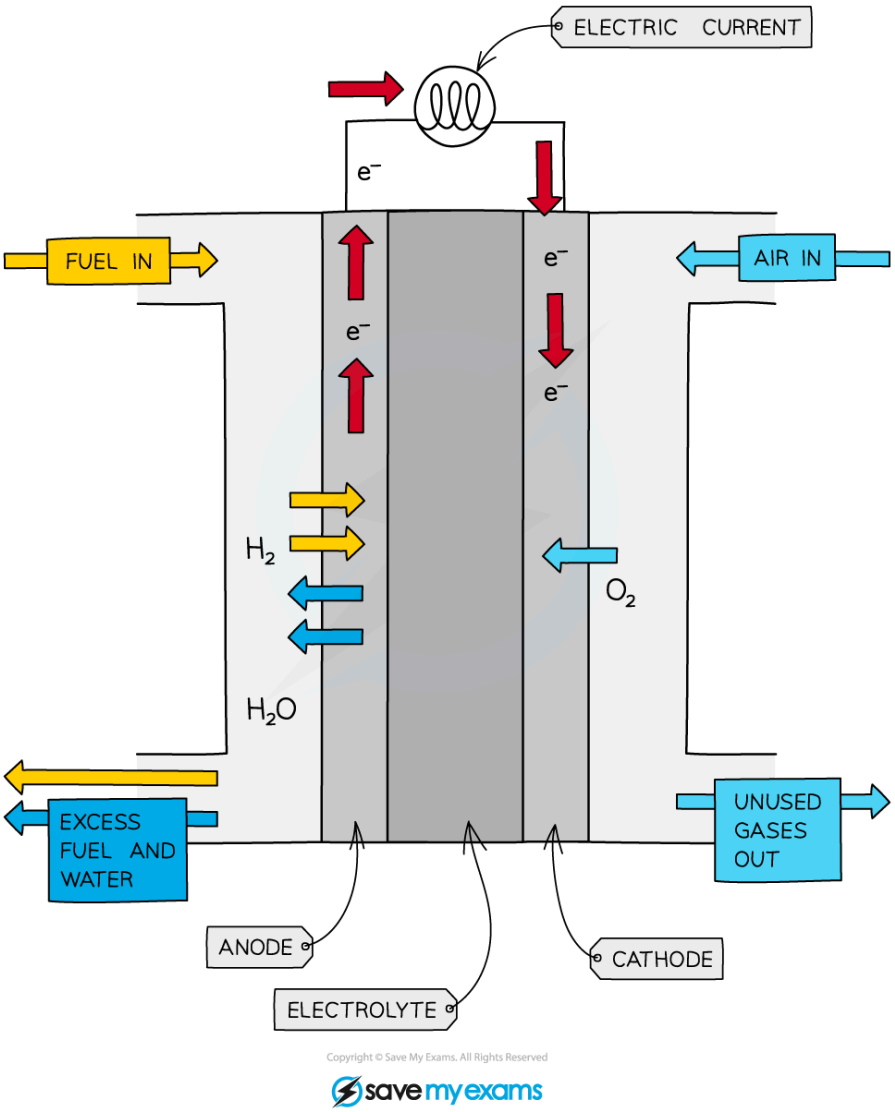

Diagram showing the movement of hydrogen, oxygen and electrons in a hydrogen-oxygen fuel cell

Advantages & disadvantages of hydrogen fuel cells

Extended tier only

- Hydrogen-oxygen fuel cells are becoming more common in the automotive industry to replace petrol or diesel engines

Advantages

- Hydrogen can be produced from water so the process is **renewable**
- They **do not produce any pollution**: the only product is water whereas petrol engines produce carbon dioxide, and oxides of nitrogen

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- They release **more energy** per kilogram than either petrol or diesel
- No power is lost in transmission as there are no moving parts, unlike an internal combustion engine
- Quieter so less noise pollution compared to a petrol engine

Your notes

Disadvantages

- Hydrogen obtained by methods that involve:
  - The combustion of fossil fuels releases carbon dioxide and other pollutants into the atmosphere
  - The electrolysis of water requires large amounts of electricity to produce
- Materials used in producing fuel cells are **expensive**
- Hydrogen is more difficult and expensive to store compared to petrol as it is very flammable and easily explodes when under pressure
- Fuel cells are affected by **low** temperatures, becoming less efficient
- There are only a small number of hydrogen filling stations across the country

Examiner Tips and Tricks

You should be able to state advantages and disadvantages of the hydrogen-oxygen fuel cells in comparison to a petrol engine.