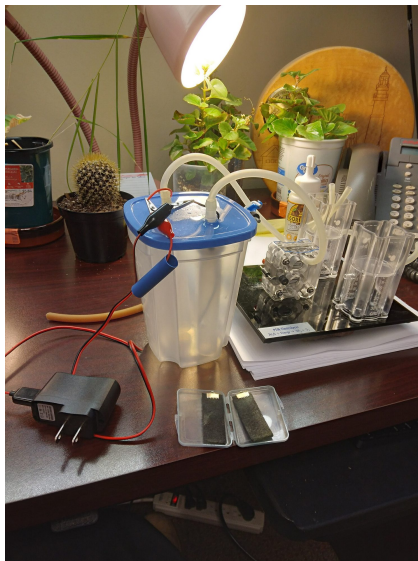


# Electrochemistry

## IGCSE Chemistry

### Electrolysis

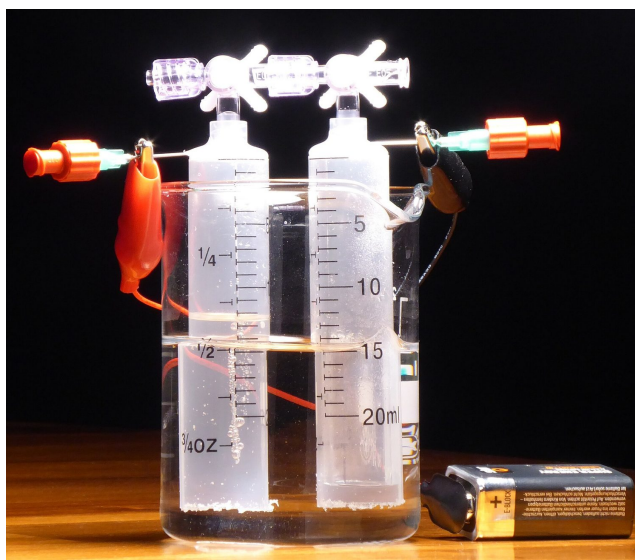
**Electrolysis** 电解 is the breaking down (**decomposition** 分解) of an **ionic compound** 离子化合物—when it is **molten** 熔融 or in **aqueous** 水溶液 solution —by passing an **electric current** 电流 through it.



*An electrolysis cell splits a compound using an electric current.*

Image: D.S. Soriano, CC BY 4.0 (commons.wikimedia.org)

It only works when the substance is molten or dissolved, because then the **ions** 离子 are free to move and carry the charge. A solid ionic compound cannot be electrolysed because its ions are locked in place.



*Electrolysis of water: gas bubbles off at each electrode and collects in the tubes above, with about twice as much hydrogen as oxygen*

Image: Rhetos, CC0 (commons.wikimedia.org)

## The electrolytic cell

The set-up is called an **electrolytic cell** 电解池. Two **electrodes** 电极 (solid conductors) dip into the **electrolyte** 电解质—the molten or aqueous substance being broken down.

- The **anode** 阳极 is the positive (+) electrode.
- The **cathode** 阴极 is the negative (–) electrode.

The electrodes are often **inert** 惰性 (they do not react), such as **platinum** 铂 or carbon/**graphite** 石墨.

## What is formed at each electrode

There is a simple rule:

- **Metals** 金属 or **hydrogen** 氢气 are formed at the cathode.
- **Non-metals** 非金属 (other than hydrogen) are formed at the anode.

For aqueous solutions, the product can depend on whether the solution is **dilute** 稀 or **concentrated** 浓. Here are the three Core examples:

Electrolyte	At the cathode (–)	At the anode (+)
molten lead(II) bromide, $\text{PbBr}_2$	<b>lead</b> 铅 (silvery liquid)	<b>bromine</b> 溴 (red-brown vapour)
concentrated aqueous sodium chloride	hydrogen (bubbles of gas)	<b>chlorine</b> 氯气 (pale green gas)
dilute <b>sulfuric acid</b> 硫酸	hydrogen (bubbles of gas)	<b>oxygen</b> 氧气 (bubbles of gas)

## How the charge moves

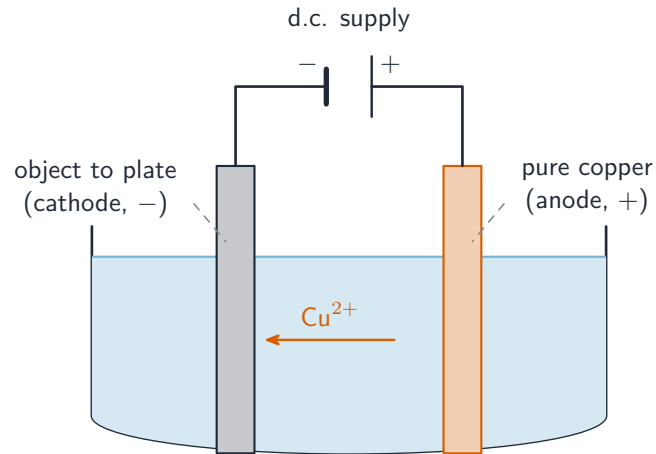
During electrolysis:



away).

To electroplate an object:

- the object to be coated is made the **cathode**;
- the plating metal is made the **anode**;
- the electrolyte is a solution containing ions of the plating metal.



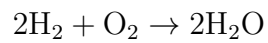
electrolyte: copper(II) sulfate solution

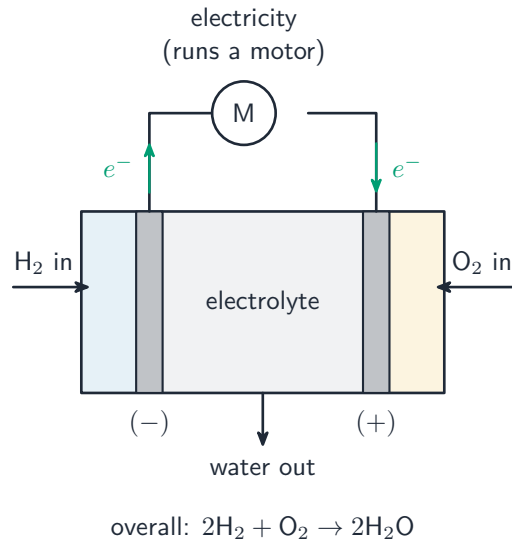
copper coats the object at the cathode; the copper anode slowly dissolves to replace it

*To electroplate, make the object the cathode and the plating metal the anode, in a solution of the plating-metal ions*

## Hydrogen–oxygen fuel cells

A **fuel cell** 燃料电池 uses hydrogen and oxygen to make electricity directly. The only chemical product is water.





*A hydrogen–oxygen fuel cell turns chemical energy straight into electricity, with water as the only product*

It is useful to compare a fuel cell with a normal petrol (gasoline) engine in a vehicle.

	Hydrogen–oxygen fuel cell	Petrol engine
Main product	water only	carbon dioxide and <b>pollutants</b> 污染物
Effect on air	clean	adds to air pollution
Fuel storage	hydrogen is hard and dangerous to store (flammable, needs high pressure)	petrol is easy to store
Source	hydrogen may be made using fossil fuels	made from crude oil

**Advantages** of the fuel cell: the only product is water, so it does not pollute the air, and it changes chemical energy into electricity efficiently. **Disadvantages:** hydrogen is hard to store and transport safely, and producing the hydrogen can still use energy from fossil fuels.