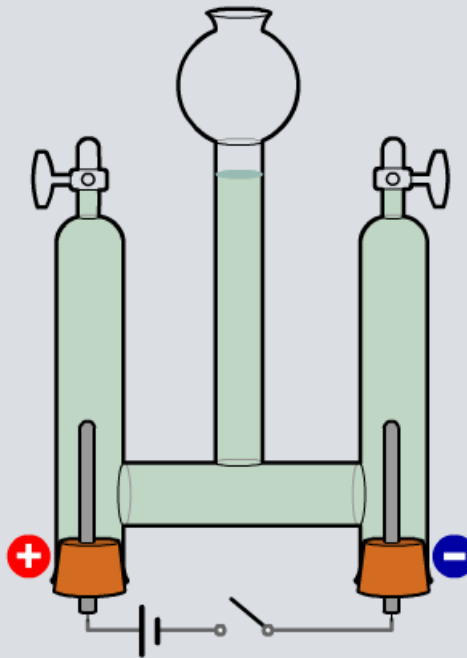
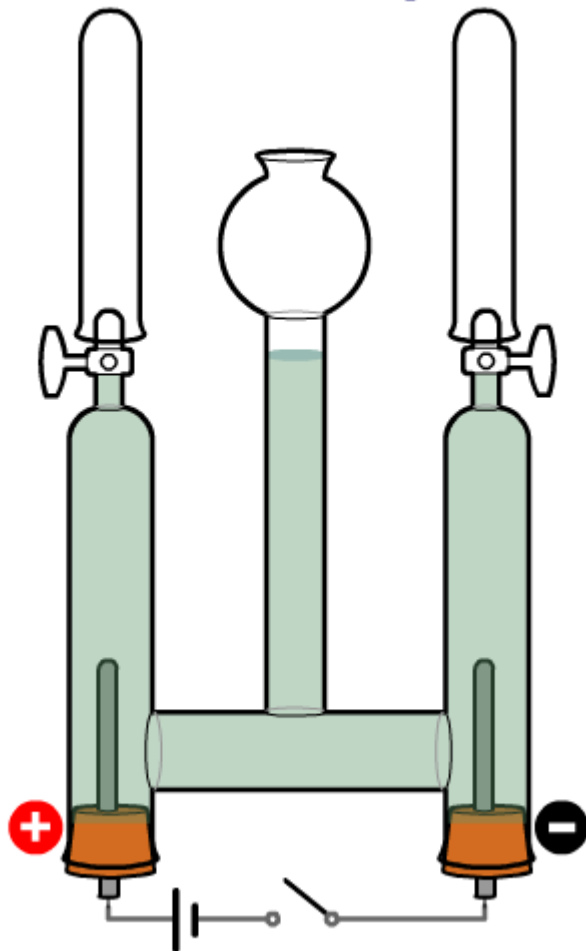


Electrolysis of NaCl





Electrolysis of sodium chloride solution



Electrolysis can be used to split a dissolved ionic compound and form new substances.

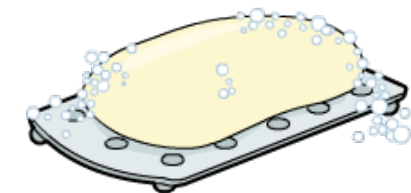
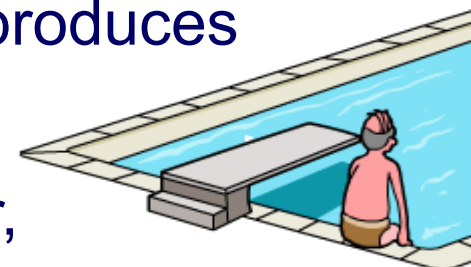
Click "**play**" to find out about the products of the electrolysis of **sodium chloride solution**.



Products of electrolysis of NaCl solution

The electrolysis of sodium chloride solution produces **three** very useful products:

- **Chlorine**: used for killing bacteria in water, for bleach and making plastics like PVC.
- **Hydrogen**: used for making margarine and fertilizers, and for rocket fuel.
- **Sodium hydroxide**: used in many chemical reactions, such as making soap, neutralizing acids and making paper.



Chlorine is expected as a product of this process, but hydrogen and sodium hydroxide are surprising products.

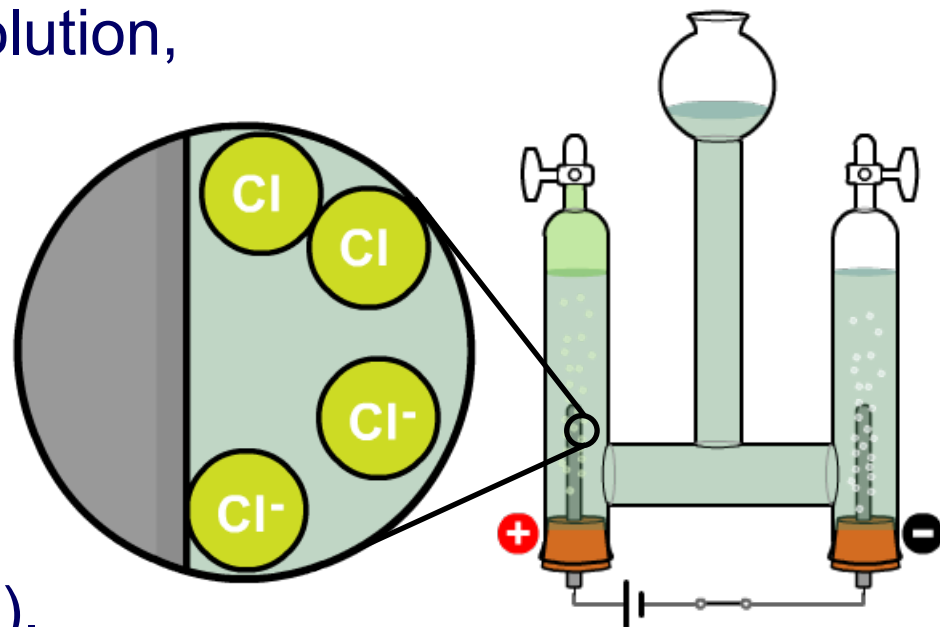
What happens at the electrodes to form these products?



How does the chlorine form?

In the electrolysis of NaCl solution, the **negative chloride ions (Cl⁻)** are attracted to the positive electrode.

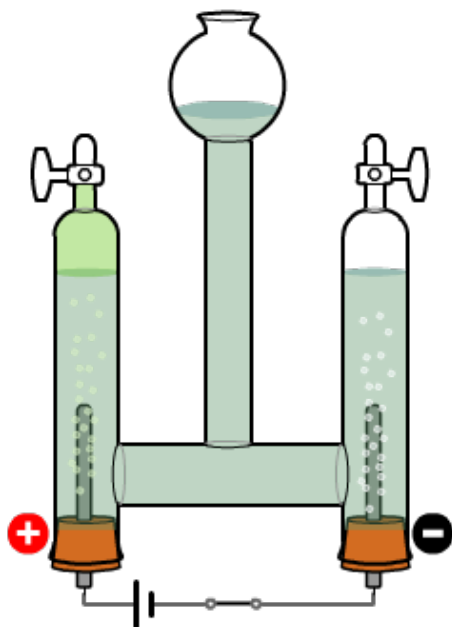
Here, the **Cl⁻ ions lose electrons** to make chlorine atoms, which then form chlorine molecules (**Cl₂**).



- Are the **Cl⁻** ions oxidized or reduced? **oxidized**
- How many electrons are lost by each **Cl⁻** ion? **one**
- How many **Cl⁻** ions join to make a **Cl₂** molecule? **two**
- What is the half-equation for this redox process?



Why is sodium not formed?



In the electrolysis of sodium chloride solution, the Na^+ ions might be expected to form **sodium** at the **negative electrode**.

Instead, **hydrogen gas** is produced here.

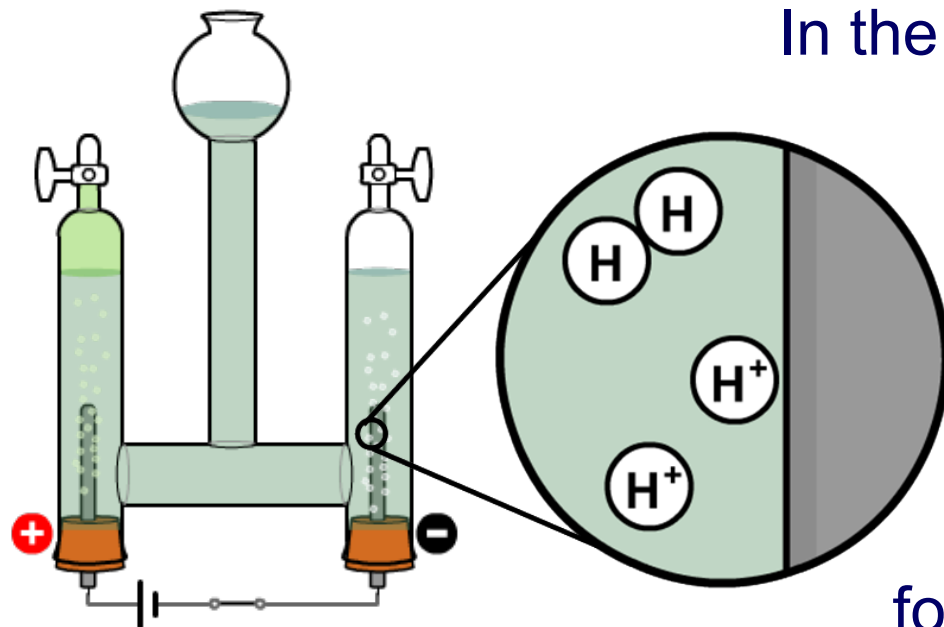
This is because sodium chloride solution also contains H^+ ions from some of the water: $\text{H}_2\text{O} (\text{l}) \rightarrow \text{H}^+ (\text{aq}) + \text{OH}^- (\text{aq})$.

At the negative electrode, the H^+ ions compete with the Na^+ ions. The H^+ ions gain electrons; the Na^+ ions stay in solution.

For all ionic compounds containing a **metal that is more reactive than hydrogen**, electrolysis of a solution of the compound will produce hydrogen rather than the metal.

How does the hydrogen form?

In the electrolysis of NaCl solution, the **positive hydrogen ions (H^+)** are attracted to the negative electrode.



Here, the **H^+ ions gain electrons** to make hydrogen atoms, which then form hydrogen molecules (H_2).

- Are the **H^+** ions oxidized or reduced? **reduced**
- How many electrons are gained by each **H^+** ion? **one**
- How many **H^+** ions join to make a **H_2** molecule? **two**
- What is the half-equation for this redox process?



How does the sodium hydroxide form?

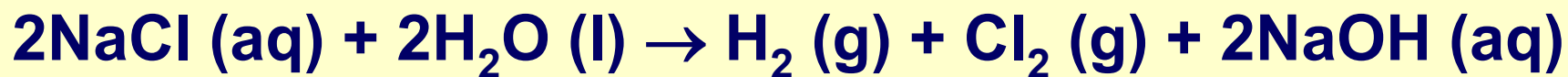
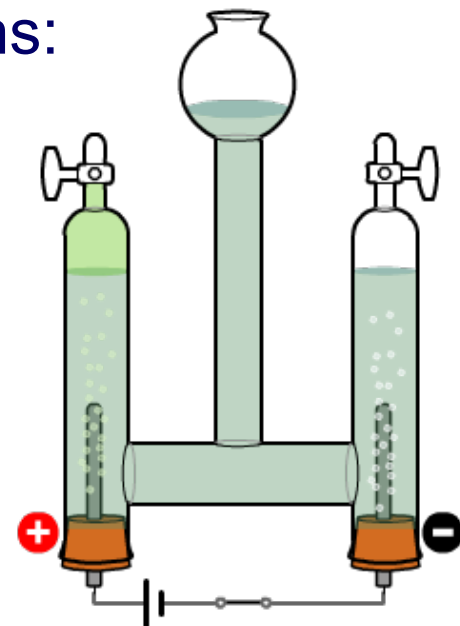
Sodium chloride solution has four types of ions:

- **Na⁺** and **Cl⁻** ions from the sodium chloride
- **H⁺** and **OH⁻** ions from the water.

The **Cl⁻** ions form chlorine at the positive electrode and the **H⁺** ions form hydrogen at the negative electrode. So, what's left?

Na⁺ and **OH⁻** ions are left behind and so a solution of **sodium hydroxide (NaOH)** is formed.

What is the overall equation for the electrolysis of a sodium chloride solution?



What are the missing words about the electrolysis of sodium chloride solution?

1. When a current is passed through a solution of an ionic compound, it electricity and undergoes .
2. The electrolysis of sodium chloride solution forms chlorine, and sodium hydroxide.
3. A solution of sodium chloride contains types of ions: Na^{2+} and Cl^{-} ions from the compound and a few H^{+} and OH^{-} ions from .



solve



Hydrogen or metal?

↑
increasing reactivity

potassium
sodium
calcium
magnesium
aluminum
(carbon)
zinc
iron
lead
(hydrogen)
copper
silver
gold
platinum

If an ionic compound contains **a metal that is more reactive than hydrogen**, electrolysis of a solution of the compound will produce hydrogen, not the metal.

Complete the table for these compounds.

| Ionic compound | Product at the negative electrode |
|--------------------|-----------------------------------|
| potassium chloride | hydrogen |
| copper sulfate | copper |
| sodium bromide | hydrogen |
| silver nitrate | silver |
| zinc chloride | hydrogen |