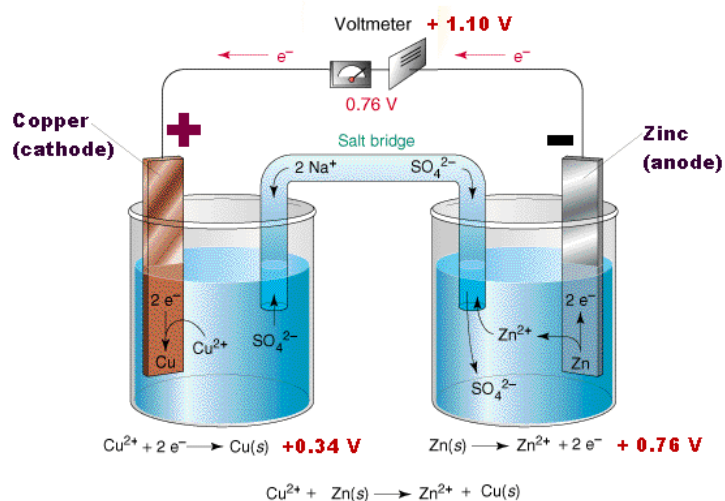


# REDOX

## BASICS

- Oxidation: loss of electron(s), the substance has been oxidized.
- Reduction: gain of electron(s), the substance has been reduced.
- Redox reaction: electron transfer (combination of an oxidation and a reduction).
- The half-equation focus on just one element: it shows clearly the electrons lost or added.
- This transfer of electrons can be used to build a cell:
  - 2 half-cells with a half-equation occurring in each one
  - Metallic blades (electrodes) to lead the electrons from a beaker to another
  - An electric load, connected to the electrodes, will use the electric current (flow of electrons)
  - The salt bridge ensure the electroneutrality of the solutions thanks to a flow of ions



- The electrode where the oxidation occurs is the anode.
- The electrode where the reduction occurs is the cathode.
- The electrons flow from the anode to the cathode, so the electric current flow from the cathode to the anode (the opposite): so the cathode is the positive terminal and the anode is the negative terminal.
- Fuel cells:

- Use a redox reaction to produce electricity
- Most of the fuel cells consume oxygen from the atmosphere and hydrogen as a fuel. The reaction leads to the production of water.
- Very expensive, no network of distribution for now
- The main applications are transportation, portable uses and stationary installations
- Experiment with the magic bottle:
  - Methylene blue and glucose in an Erlenmeyer flask
  - When we shake the flask, it becomes blue
  - When we stop, it becomes colorless
  - Methylene blue belongs to a redox couple: the oxidized form is blue and the reduced form is colorless
  - When we shake, the oxygen in the air start the oxidation of the methylene blue
  - When we stop, it is reduced by the glucose
- Oral presentations on Volta and Galvani:
  - 2 different theories
  - Galvani thought the electricity was within the bodies (experiment with the frog's leg)
  - Volta showed that a cell could be built just with metals and ions
  - The Galvani's theory inspired the Frankenstein's story

ADVANCED
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- In the fuel cell, the hydrogen is oxidized (anode) and the oxygen is reduced (cathode).
- $H^+$  ions cross the electrolyte from the anode to the cathode
- Hydrogen station: about 1 million \$ !!!
- The cell is very expensive because of the platinum on the electrodes and because of the membrane (the electrolyte between the 2 electrodes): ~ 1000 € by square meter and ~ 10 m<sup>2</sup> are needed!
- Different families of fuel cells:
  - They don't have the same electrolyte
  - They don't work at the same temperature
  - Some fuel cells can use another fuel like methane

- Galvani's experiment: the living tissues (frog's leg) are playing the role of the electrolyte. The leg is twitching because the electric current will flow through the nerves, controlling the muscles.

LINKS
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- Using the fuel cells, you can make a link with the solar panels and the renewable energies, the environment and the Global Warming
- Using the Volta/Galvani theories, you can make a link with the evolution of theories in science
- Evolution of science: mechanic
  - Aristotle thought that a force was necessary to have a motion
  - Galileo thought that a force was necessary to change a motion and proposed the law of inertia
  - Kepler observed the motions of planets and satellites and proposed 3 empirical laws
  - Newton developed Galileo's ideas and explained the Kepler's laws
  - Einstein and his theory of special relativity (twin paradox)
- Evolution of science: structure of the matter
  - The Greeks with a philosophical approach: there must be an elementary component of the matter that **you can't divide** (literally "atomos")
  - Thomson with the model of the plum pudding: negatively charged particles i.e. electrons embedded or suspended in a sphere of positive charge (electrons presented as plums inside the bowl of pudding)
  - Rutherford's experiment: alpha particles sent through a gold foil showed that a big part of the atoms was void. There should be a positive nucleus at the center and electrons turning around (just like a planet with satellites)
  - New models with electrons represented as a kind of cloud around the nucleus
- Evolution of science: link with the global warming controversy