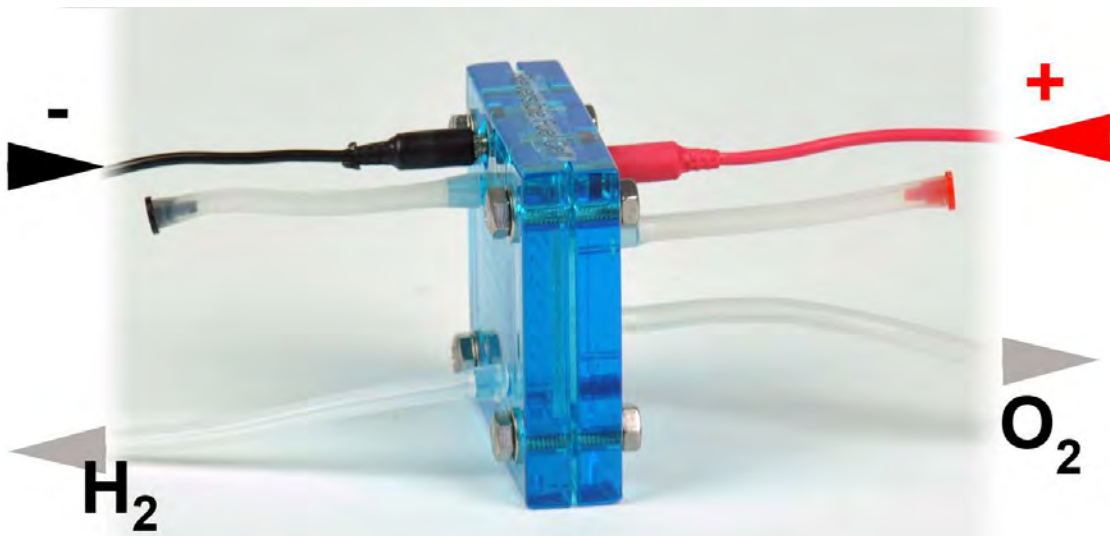


PEM FUEL CELL GENERAL INFORMATION

AES 7.0

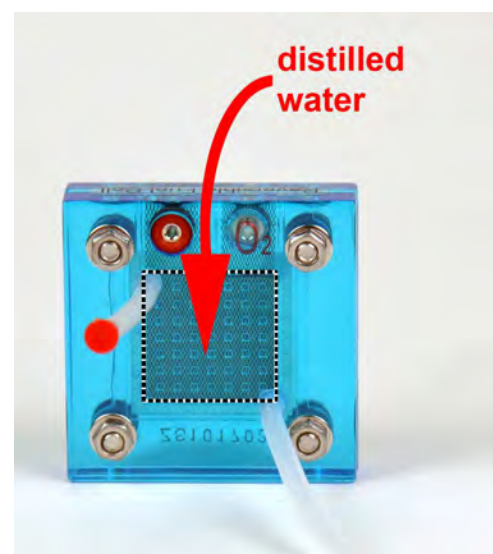
We become acquainted with a special cell, we call it "Fuel Cell". This cell uses hydrogen gas (H_2) and oxygen (O_2) to produce electricity and water (H_2O).

A **regenerative hydrogen fuel cell** uses electricity and water to produce hydrogen and oxygen:



When the fuel cell is operated in regenerative mode, the anode for the electricity production mode (fuel cell mode) becomes the cathode in the hydrogen generation mode (reverse fuel cell mode), and vice versa.

When an external voltage is applied, water at the cathode side will undergo electrolysis to form hydrogen and oxide ions; oxide ions will be transported through the electrolyte to anode where it can be oxidized to form oxygen. In this reverse mode, the polarity of the cell is opposite to that for the fuel cell mode.



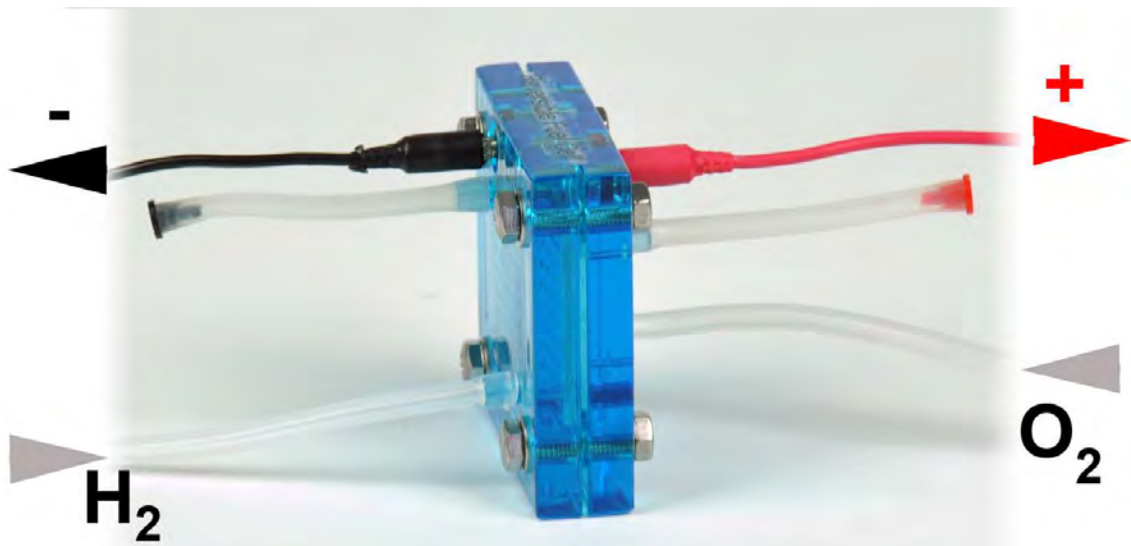
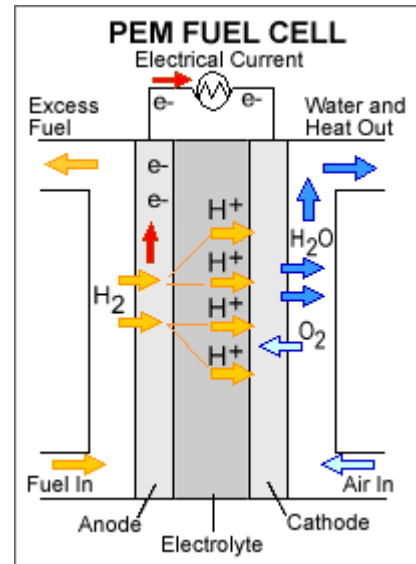
PEM FUEL CELL GENERAL INFORMATION

Proton exchange membrane fuel cells (PEMFC), also known as polymer electrolyte membrane (PEM) fuel cells transform the chemical energy liberated during the electrochemical reaction of hydrogen and oxygen to electrical energy.

A stream of hydrogen is delivered to the anode side of the membrane. At the anode side it is split into protons and electrons.

The newly formed protons permeate through the polymer electrolyte membrane to the cathode side. The electrons travel along an external load circuit to the cathode side, thus creating the current output of the fuel cell.

Meanwhile, a stream of oxygen is delivered to the cathode side. At the cathode side oxygen molecules react with the protons permeating through the polymer electrolyte membrane and the electrons arriving through the external circuit to form water molecules.



General information:

The PEMFC is a prime candidate for vehicle and other mobile applications of all sizes down to mobile phones, because of its compactness.

IMPORTANT

- The positive and the negative poles of the PEM reversible fuel cell must be **correctly connected** to the power supply, otherwise damage may result!

It is recommended to use the 2 new AA alkaline batteries with 1.5 V (total voltage of 3 V) to "insert" power to the PEM reversible fuel cell.

- The membranes in the PEM reversible fuel cell are to be used only when they are **hydrated**. Inject water only into the positive (oxygen) side of the fuel cell and allow to soak for 3 minutes. The membranes will be damaged if connected to a power supply (or other power sources like a solar panel or hand generator e. g.) when they are dry!

The water management is crucial to performance: too much water will flood the membrane, too little will dry it; in both cases, power output will drop. Water management is a very difficult subject in PEM systems, primarily because water in the membrane is attracted toward the cathode of the cell through polarization

- It is highly recommended to place the PEM Reversible fuel cell inside an air-tight plastic bag. This will protect it when you are not using the cell.

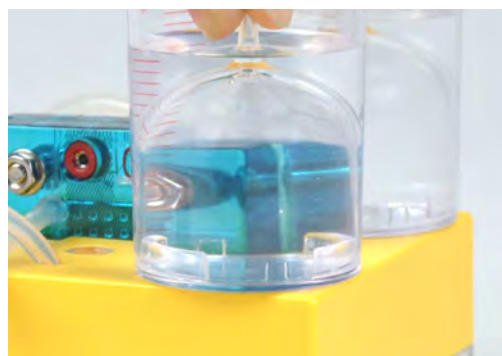
WE PRODUCE OXYGEN AND HYDROGEN

AES 7.1

With our cell we can split water into Oxygen and Hydrogen.
When applying electrical energy, our fuel cell acts as an "Electrolyzer".

Experiment:

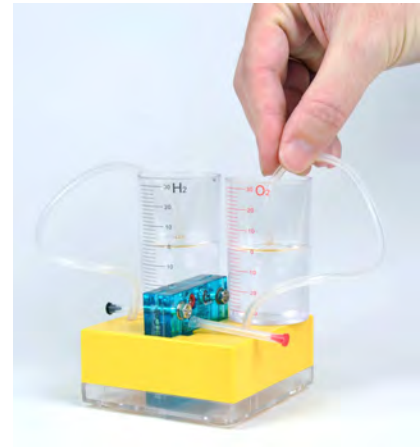
- Put the fuel cell unit to a flat surface
- Fill the syringe with distilled water
- Take off the red cap on the Oxygen side of the cell and connect the syringe
Fill in the cell with distilled water until it flows into the lower tube
- Fill both containers up to the "0" - line with water.
- Place inner containers into the gas-cylinders. Take care that the gaps are not blocked by the inner plastic rims of the cylinders. Make sure that the water level is still at the "0" - position.



WE PRODUCE OXYGEN AND HYDROGEN

AES 7.1

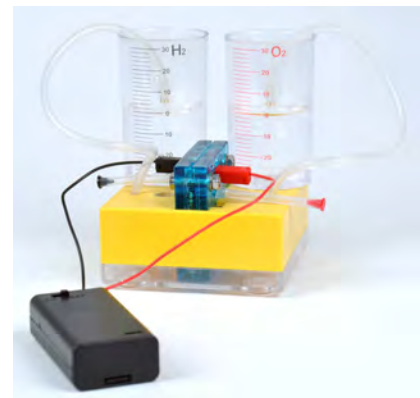
- Connect the long plastic hoses with the nozzles of the inner containers.



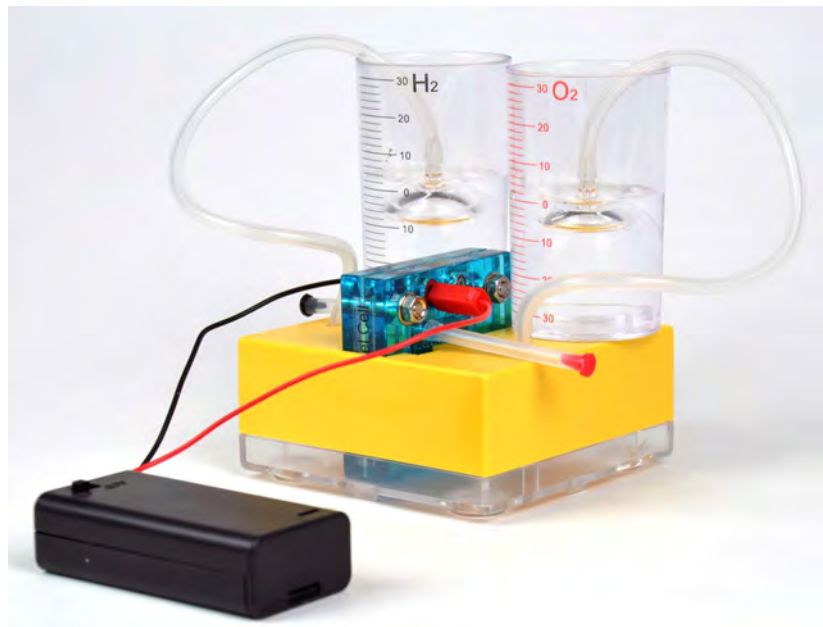
- Connect the battery pack with the Fuel cell (Electrolyzer) and switch on.

TAKE CARE ON THE POLARITY!

- A wrong polarity can destroy the fuel cell!



What happens?



Result:

The reversible fuel cell (Electrolyzer) is splitting up the water into Hydrogen and Oxygen gas. These gases we collect in the two containers.

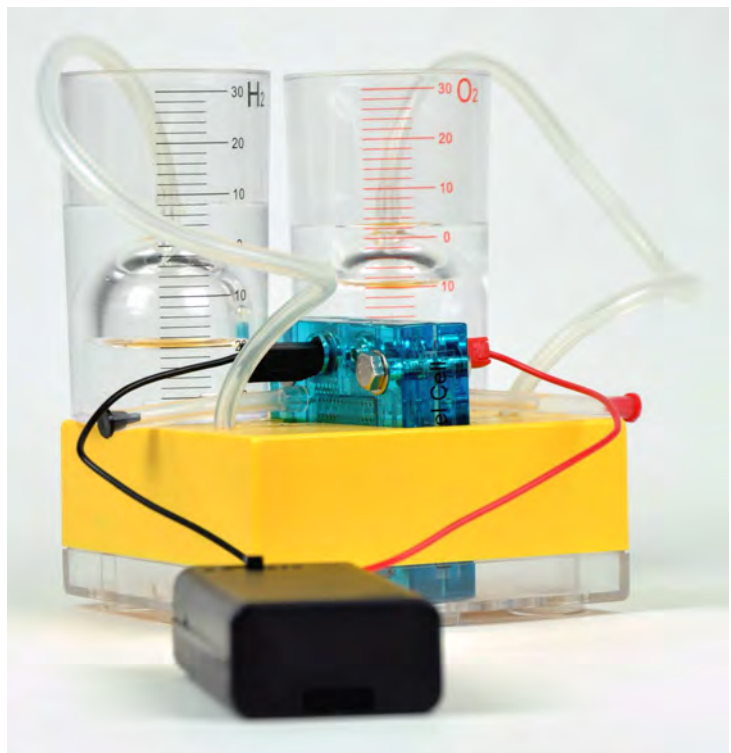
WE PRODUCE OXYGEN AND HYDROGEN

AES 7.1

Pay regard to the volume of the gases produced. To get a correct reading watch the cylinder from a horizontal position. Insert the volumes in the column below.

	start	15 s	30 s	45 s	60 s	75 s	90 s	105 s	120 s
O ₂									
H ₂									

You should produce a volume of about 20 ml of Hydrogen or more. Upon that remove the cables of the battery pack generator from the Electrolyzer.



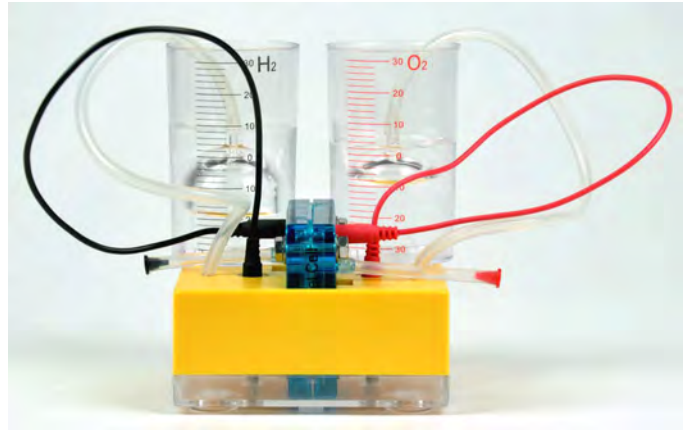
Physical explanation of the energy conversion:

Electrical energy is converted into electrochemical energy by means of an "Electrolyzer". This energy we use to split water into Hydrogen and Oxygen.

With our cell (the Electrolyzer) we have split water into Oxygen and Hydrogen. These gases we use now to "make" electrical energy again.

Experiment:

- You have produced about 20 – 25 ml of Hydrogen
- Connect the fuel cell with the sockets on the surface of the yellow housing. These sockets have pins at the bottom.
- Move the switch of the trolley to the position "battery driven".
- Carefully take the complete unit and attach it to the trolley. Insert the pins of the housing into the sockets of the trolley.
- Dispose the trolley with the PEM – cell unit to a plain surface (without inclination)



What happens?

Result:

The Fuel cell powers the motor of the trolley. So the trolley is moving.

Note:

The surface where our trolley is moving must be plane and smooth.

Operation method of the fuel cell:

When applying load, the reversible fuel cell is able to convert electrical energy coming from hydrogen and oxygen through an electrochemical process.

Additional experiments:

Of course you can drive other units consuming less power also with the fuel cell, like the motor with propeller or the LED.