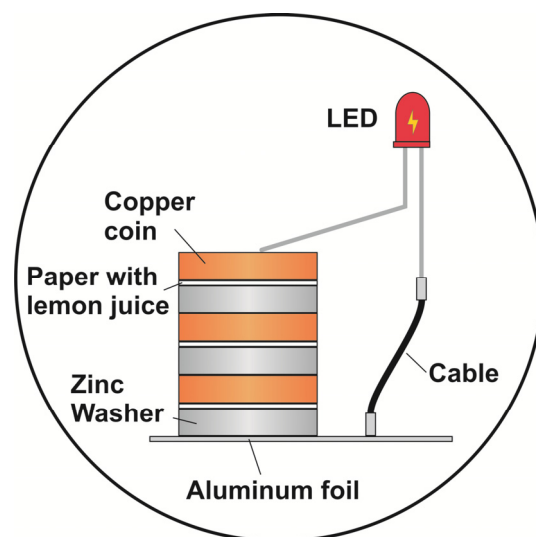


Homemade Voltaic Pile

Equipment:

5 clean coins with copper shell of the same type
(5 Euro cent coins, US pennies, etc.)
5 zinc washers (similar diameter as the coins)
blotting paper or construction paper
aluminum foil
pencil
scissors
small plate (ceramic, plastic)
red LED (light emitting diode)
cable
alligator clip
small beaker or bowl
tweezers
paper towel
digital multimeter (optional)



Chemicals:

lemon juice

Safety:

—

Procedure:

Preparation: A coin is traced 5 times on the paper with a pencil and subsequently, coin-size paper pieces are cut out. Some lemon juice is poured into the beaker or bowl. A piece of aluminum foil (about 8 x 4 cm) is folded so that it forms a strip. The longer leg of the LED is carefully bent and the shorter leg is connected to the cable by means of an alligator clip.

Procedure: The aluminum strip is placed in the middle of the plate and then a washer on the aluminum strip. A piece of paper is soaked in the lemon juice (it should be wet throughout but not dripping; if necessary it should be placed on a piece of paper towel to remove excess liquid) and laid on top of the washer. Subsequently, a coin is placed on top of the soaked paper. This pattern—washer, paper, coin—is repeated up to four times; the stack should end up with a coin.

Finally, the longer leg of the LED is held against the coin at the top of the stack and the end of the cable against the aluminum foil strip at the bottom of the stack.

Optionally, the voltage of the wet cell battery produced in this way can also be determined. For this purpose, the multimeter is set to measure DC voltage (direct current). Subsequently, the probes of the multimeter are connected to the two ends of the battery by placing one probe tip on the aluminum foil strip and the other to the coin on top of the stack.

Observation:

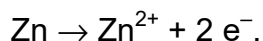
The LED lights up.

A voltage of about 0.8 to 0.9 V per cell (combination washer, paper, coin) can be read off the multimeter.

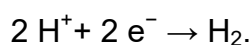
Remark: One should first try to make the LED light up with three cells and then with four or even five.

Explanation:

At the zinc electrode, zinc atoms dissolve into the liquid electrolyte as electrically charged ions (Zn^{2+}), leaving two negatively charged electrons (e^-) behind in the metal:



Since oxidation takes place, we know we are dealing with an anode. The accumulation of electrons gives this electrode a negative charge. The Zn^{2+} ions, along with H^+ ions delivered by the acids in lemon juice (mainly citric acid), migrate through the electrolyte from the zinc to the copper electrode. At the copper electrode, two positively charged hydrogen ions (H^+) from the electrolyte accept two electrons and form hydrogen gas:



This means that the H^+ ions are reduced (cathode). The “electron suction” caused by the consumption of electrons gives this electrode a positive charge. Consequently, an electric voltage develops between the two electrodes which can be measured with the help of the multimeter.

When the circuit is closed by a wire, electrons are transferred from the zinc through the external circuit to copper. This electron flow can be used to make an LED light up.

Disposal:

The coins and washers can be cleaned with tap water. The paper soaked with lemon juice can be disposed of in the household waste.