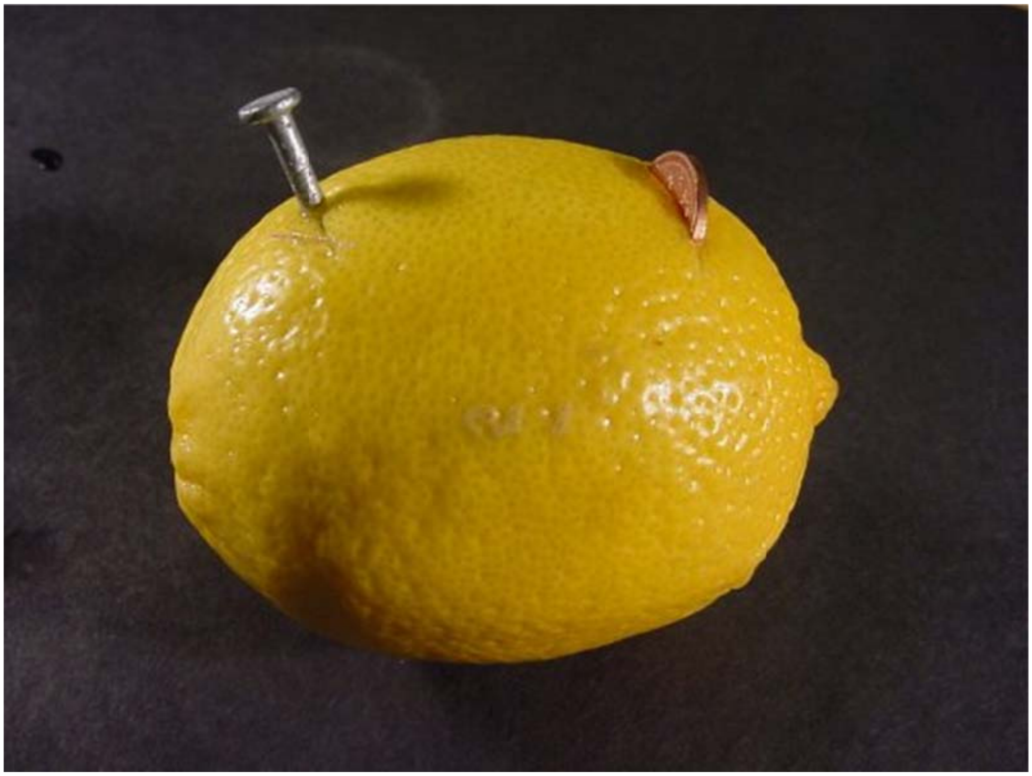
Lemon Battery

From http://hilaroad.com/camp/projects/lemon/lemon_battery.html



More science and technology projects from Hila Science
(geodesic domes, sundials, kites, trebuchets......)

Follow these links to video clips supporting this project:

Introduction to Electricity - Hila Video on Youtube

Build a Lemon Battery - Hila Video on Youtube

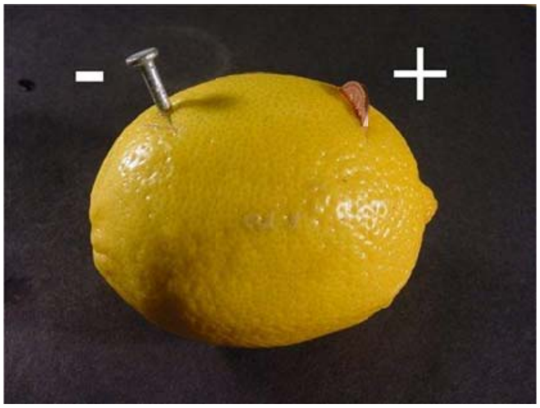
Creating a battery from a lemon is a common project in many science text books. Successfully creating one of these devices is not easy.
Batteries consist of two different metals suspended in an acidic solution. Copper and Zinc work well as the metals and the citric acid content of a lemon will provide the acidic solution.

Batteries like this will not be able to run a motor or energize most light bulbs. It is possible to produce a dim glow from an LED.

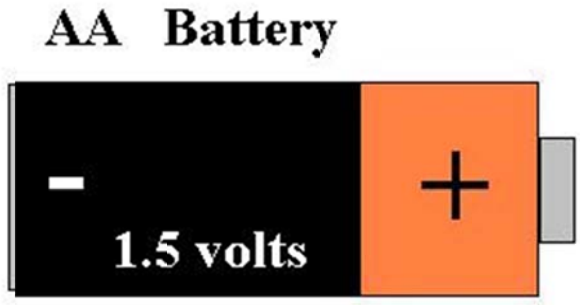
The picture at the top of this page shows a basic lemon battery, a lemon, copper penny and zinc coated nail.

The lemon: A large, fresh, "juicy" lemon works best.
The nail: **Galvanized** nails are coated in zinc. I used a 2" galvanized common nail.
The penny: Any copper coin will work. (Canadian pennies from 1960 - 2001 all worked)

Creating the battery: Insert a penny into a cut on one side of the lemon. Push a galvanized nail into the other side of the lemon.
The nail and penny must **not** touch.

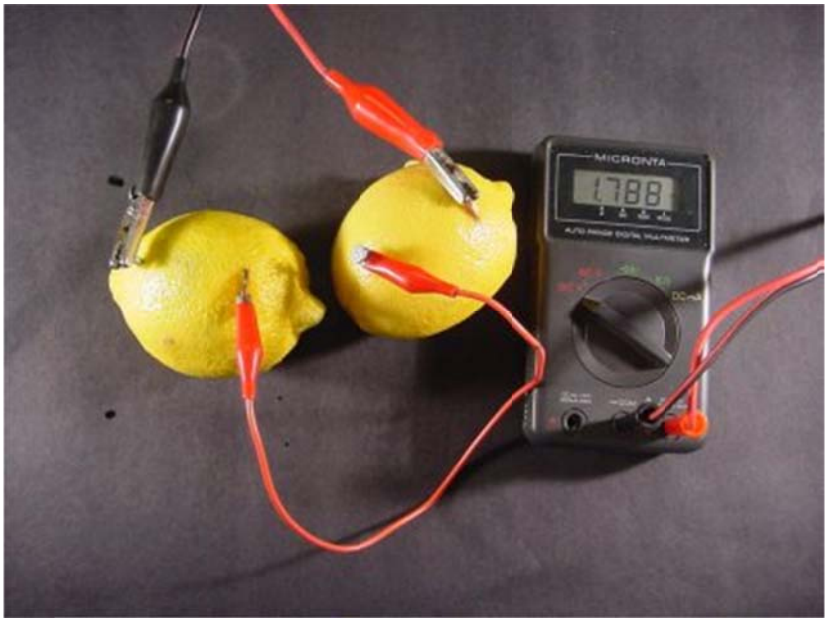


This is a single cell of a battery. The zinc nail and the copper penny are called **electrodes**. The lemon juice is called **electrolyte**.
All batteries have a "+" and "-" terminal. Electric current is a flow of atomic particles called **electrons.** Certain materials , called **conductors**, allow electrons to flow through them. Most metals (copper, iron) are good conductors of electricity. Electrons will flow from the "-" electrode of a battery, through a conductor, towards the "+" electrode of a battery. **Volts** (voltage) is a measure of the force moving the electrons. (High voltage is dangerous!)

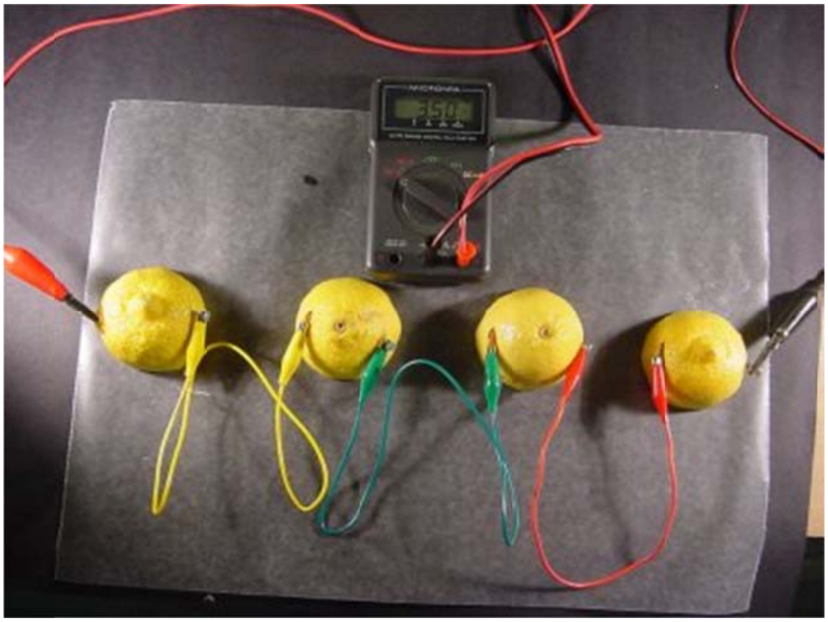


I have connected a volt meter to our single cell lemon battery. The meter tells us this lemon battery is creating a voltage of 0.906 volts.
Unfortunately this battery will not produce enough **current** (flowing electrons) to light a bulb.

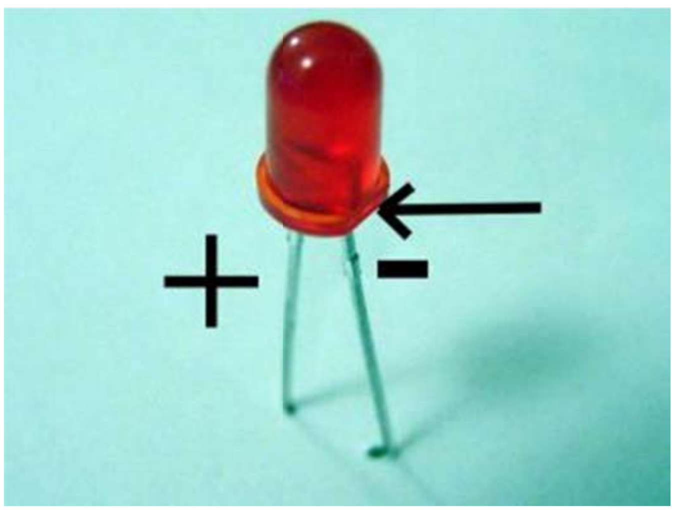
To solve this problem we can combine battery cells to create higher voltages. Building more lemon batteries and connecting them with a metal wire from "+" to "-" adds the voltage from each cell.



The two lemon batteries above, combine to produce a voltage of 1.788 volts. This combination still does not create enough current to light a small bulb. Note the red wire connecting the batteries is joined from "+" (penny) to "-" (galvanized nail).



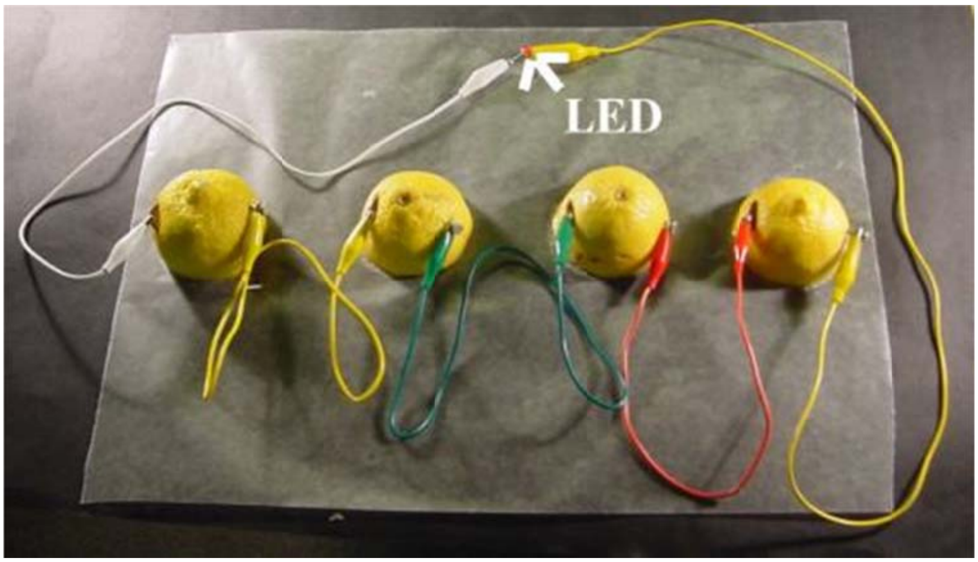
Four lemon batteries create a voltage of 3.50 volts. We should be able to light up a small device like an LED (Light Emitting Diode).
Note the connecting wires go from "+" to "-" on each battery.



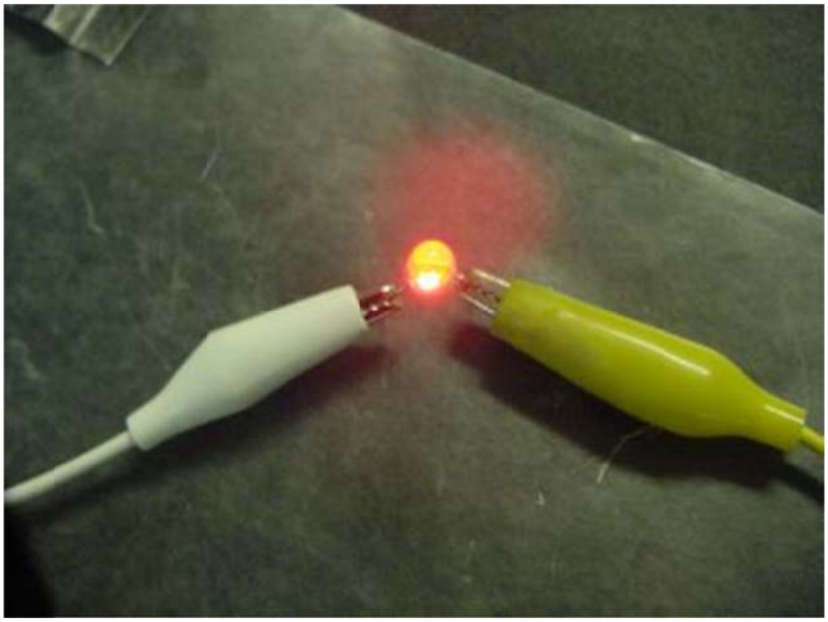
LED

To turn on an LED you must determine the "+" and "-" connections. If you look closely at the red plastic base of an LED you will notice a "flat" spot (indicated by arrow above). The wire that comes out beside the flat spot must connect to the "-" side of a battery, the other wire to the "+" side.

Important information about LEDs: LEDs are designed to work at very low voltages (~ 2V) and low currents. They will be damaged if connected to batteries rated at over 2 volts. LEDs require resistors to control current when used with batteries rated at over 2 volts. Lemon batteries produce low current. It is OK to connect an LED to a lemon battery.



In the above image, electrons flow from the "-" (nail) end of our lemon battery through the LED (making it glow) then back to the "+" (penny) end of the battery. This is an electronic circuit. The LED glows **dimly** with this configuration.



Improving your battery.

The quality of the copper and zinc can be a problem for a battery like this. Pennies in particular are rarely pure copper.
Try substituting a length of 14 gauge copper wire (common house wire) for the penny. Experiment with different lengths and configurations of electrodes. Other sources of zinc and copper may be found in the plumbing supply department of a hardware store.

Here is a design for a battery constructed from a film container.

Use our film cannister battery to power a calculator.

The first battery was created in 1799 by Alessandro Volta . Today batteries provide the power for an amazing variety of devices, everything from flashlights to robots, computers, satellites and cars. Inventors and researchers continue to improve the battery, designing batteries that last longer and that are more friendly to our environment.

Understanding how batteries actually work requires a knowledge of chemistry. The most important factor in battery design is the electrical relationship between the two metals used in the battery. Some metals give electrons away while other metals accept extra electrons.   Chemists have investigated metals and created an "electric potential" table comparing different metals.

Electric Potential

Metal	Potential, Volts	Metal	Potential, Volts
Calcium	+2.20	Hydrogen	0.000
Magnesium	+1.87	Antimony	-0.190
Aluminum	+1.30	Arsenic	-0.320
Manganese	+1.07	Bismuth	-0.330
Zinc	+0.758	Copper	-0.345
Chromium	+0.600	Mercury	-0.799
Iron	+0.441	Silver	-0.800
Cadmium	+0.398	Platinum	-0.863
Nickel	+0.220	Gold	-1.100

Some metals give up electrons more easily then others. This difference is exploited in a battery to create a flow of electrons.

The above table can be used to calculate theoretical voltages for various metal combinations.

More information can be found at

http://hyperphysics.phy-astr.gsu.edu/hbase/chemical/electrochem.html

http://en.wikipedia.org/wiki/Lemon_battery