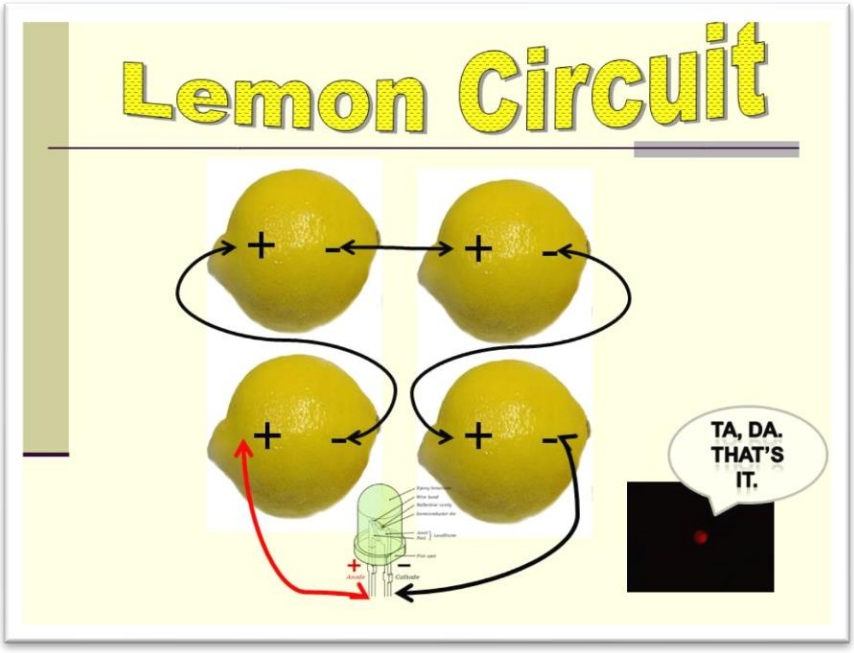
CHILDREN'S MUSEUM HOUSTON

Lemon Light Up



Description

Create a battery from a lemon. Explore how lemon juice reacts with zinc and copper to produce an electric current which can be used to power a light bulb and digital timer.

Background

Every battery has 2 electrodes:

Cathode – positive terminal

Anode – negative terminal

In each lemon battery, the ***anode*** (-) is the zinc metal that coats the nail. The ***cathode*** (+) is the coper in the penny. (Note: pennies made before 1982 work best as they are made primarily of copper.) The citric acid in the juice of the lemon serves as an ***electrolyte***, a solution that can conduct electricity. The citric acid of the lemon causes the zinc and the copper to undergo a chemical reaction. A potential difference (difference in energy) is created between the two terminals causes a flow of electrons from the zinc anode through the lemon juice toward the direction of the copper cathode. This process is driven by oxidation (loss of electrons) at the surface of the zinc terminal and reduction reactions (gaining of electrons) at the surfaces of the copper terminal. This flow of electrons is called an electrical current. The electrons continue to travel through the lead wires in a circuit that powers the LED and/or the digital timer.

One lemon can produce a circuit with a voltage (potential difference between 2 points in the circuit) of about 1volt (V). By connecting the lemons in a chain (in series) we can increase the voltage of the circuit to power objects with larger energy requirements.

Materials

- Multi-meter (optional) - Example: https://tinyurl.com/w5pl5g6
- 6 lemons
- 6 iron nails with zinc coating
- 6 pennies (must predate 1982)
- 7 double-sided alligator clip leads – Example: https://tinyurl.com/wjvcds7
- 5mm LEDs - Example: https://tinyurl.com/secvmel
- Digital timer/kitchen timer – Example: https://tinyurl.com/t6cfapd

Procedure

1. In a lemon, make 2 holes about 1 inch apart.
2. Insert the nail (anode) and the penny (cathode) into the holes.
3. Attach one alligator lead to the nail and one to the penny.
4. Attach the open ends of the leads to the multimeter. Ensure the dial on the multimeter is set to 20 in voltage (V) section of the range. What is the voltage of your circuit?
5. Unhook the multimeter and attach the leads to the pins sticking out of the LED. (Note – long pin (+) should link to penny and short pin (-) should link to copper side of lemon battery.)
   Does the LED light up? Why do you think this is?
6. Repeat steps 1 and 2 for the remaining 5 lemons.
7. Use the remaining alligator leads to hook the lemon batteries together in a series. (Note the lead attached to the penny of one lemon should attach to the nail of the next lemon and so on.) Leave the circle open so that a lead remains of either side of the chain. (One lead should be attached to a nail and one lead should be attached to penny on the ends of the series.)
8. Repeat step 4 to test the voltage of this circuit. Has the voltage increased or decreased by adding more batteries to the series?
9. Unhook the multimeter and attach the open ends of these leads to the LED as in step 5 to make a closed circuit.
   What happens this time? Does the LED light up? Why is this so?
10. Experiment with attaching the digital timer to the circuit. Ensure the negative terminal of the timer is hooked to the nail (anode) on the open end of your series and the positive terminal is hooked to the penny (cathode) on the open end of your series.
    Is the circuit generating enough power to turn on the timer? If not, what can you try to increase the voltage of the circuit?

Additional Resources:

For more information on how to set up and use a voltmeter, see this article:
https://learn.sparkfun.com/tutorials/how-to-use-a-multimeter/all