Fruit Battery

Activity

In this activity you will make batteries that can light up LED bulbs using different everyday fruits or potatoes. You will also determine how many of the same type of fruit you will need to light up different coloured LEDs.

Ensure you read the instructions before conducting the activity. The accompanying video also shows how the activity is done and can serve as a guide.

The Science

Batteries contain a negative electrode, a positive electrode and an ion conducting electrolyte that facilitates ion transfer. In the example of a lemon battery setup, the copper metal is the positive terminal, the zinc metal the negative terminal and the juice in the lemons form the electrolyte.

The ions in the juices attack the zinc metal to form zinc ions which move through the lemon juice to the copper metal. But this can only be seen when the ions are converted to electrons. The conversion of ions to electrons will occur once we have connected both terminals to other negative and positive terminals of a device that requires energy, for example the LED light. This means that we have closed the circuit. As a result we are able to transfer the electrons through the connections between the positive and negative terminal, to the device (LED light) to give energy (the bulb lighting up).

Depending on the number of ions these juices produce, they are able to have higher or lower voltages. In essence, the fruits that appear to have higher voltages produce more ions that attack the electrodes, compared to the fruits that have lower voltages.

Materials

- 5-10 pieces of a fruit or potato*
- Copper coin or copper coated nails (**one** for each piece of fruit)
- Zinc coated nails (**one** for each piece of fruit)
- Crocodile clips (**two** for each piece of fruit)
- Different coloured LEDs (red need the lowest voltage, blue need the highest voltage to light up)
- Multimeter or voltage meter (optional)

* Start by trying tomatoes (cherry size good), baby potatoes (or large ones cut to pieces) or lemons, which all work well. Potatoes produce more charge if they have been boiled a little, be sure they are still firm. The potatoes we used in the instruction video had been boiled for 5 minutes. Have adult supervision if you decide to boil your potatoes, and don't start the activity until they have completely cooled.

Activity instructions

1. Insert a copper coated nail (positive terminal) into your first piece of fruit. Insert all your nails about 2cm deep.
2. Next, insert the zinc coated nail (negative terminal) about 1-1.5cm away from the copper nail.
3. Repeat steps one and two for a second piece of fruit.
4. Using a crocodile clip, connect the negative terminal (zinc nail) in one piece of fruit to the positive terminal (copper nail) in the next piece of fruit until all the piece are connected.
5. Now, connect the positive terminal (copper nail) of the first piece of fruit to the longer leg of your LED bulb.
6. Next, connect the negative terminal (zinc nail) on the last piece of fruit to the shorter leg of your LED bulb. Does your LED light up? (try the Red LED first, then any other colours)
7. If the LED does not light up or is very dim, connect more pieces of fruit into your circuit (steps 1 to 4) until you get enough voltage to make the LED light up brightly.

Tip - If you have access to a multimeter, with the help of an adult, use it to measure the voltage of the fruit battery before and after you add more fruit pieces, this will let you know the exact voltage being produced to light up your LEDs. The colour of the LED indicates the voltage it needs: starting with the least needed voltage the usual order is: red, orange, yellow, green, blue than white.

More to try

1. Try different fruits or type of potato. Which produces the highest voltage?
2. Boiled potatoes are supposed to provide a higher voltage. What is the difference if you try the same potatoes, first raw and then after boiling for about 5-8 minutes?
3. Vary the distances between the copper nail and the zinc nail. First bringing them closer together (less than 0.5cm apart) then further apart (more than 1.5cm apart) and record the differences in how the fruit battery lights up your LED bulb.

Things to think about

1. What makes different fruit have different voltage, and power the LED differently?
2. Based on your knowledge of the voltage of your fruit battery, how many pieces of fruit would you need to power a small electric vehicle?
3. Why do the different coloured LED bulbs require different battery voltages to light up?
4. Why must the copper and zinc nail be separated from each other? Do you think there is a difference when the distance between them is changed?
5. How long do you think your fruit battery will last for before it dies? Why do you think this happens?