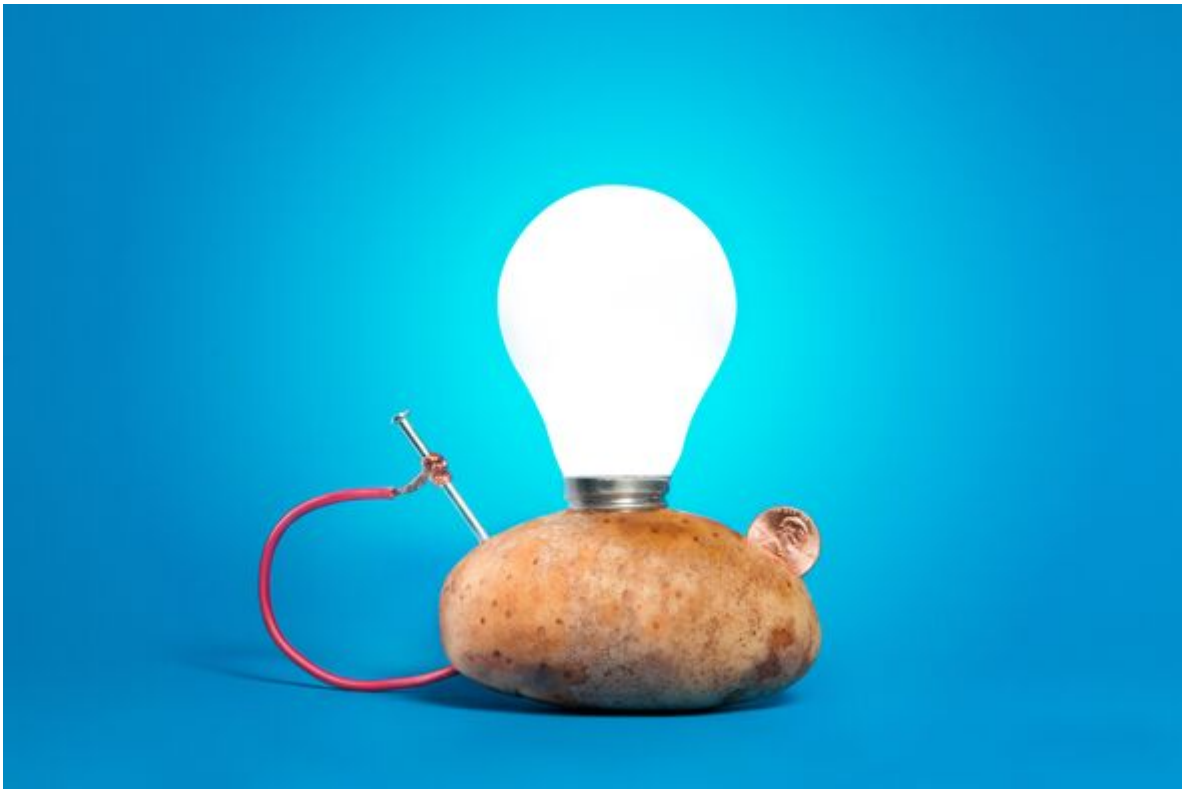
Generating Electricity with Produce

- Did you know that you can generate electricity with the energy that is stored inside of produce, like fruits and vegetables?

- The chemical substances in fruits, especially acidic citrus fruits, can be converted into energy. To do this, the fruit is used as the energy source for a battery.

- Two different metals (usually one zinc and one copper) are inserted into the fruit and act as the positive and negative poles. A wire acts as a conductor between the poles and can be used to conduct a small amount of electricity.



Testing Produce

Follow the steps below to conduct an experiment with three parts.

- In part one, you will test your multimeter to make sure it can measure voltage correctly.
- In part two, you will test different produce to determine which fruits are best for conducting electricity.
- In part three, you will test to determine how many fruits are needed to generate enough electricity to light an LED bulb

Part One: Test Multimeter

Read the directions that are included with your multimeter or ask your teacher for a quick demonstration. It is important to test your multimeter with a battery first because batteries produce a known amount of voltage. Using a battery to test voltage will let us know if our multimeter is reading the voltage output correctly. Follow the steps below to test your multimeter.

Regular batteries work by using one copper and one zinc electrode. The electrodes are placed in an acidic solution, and then a chemical reaction occurs. This chemical reaction generates electricity. The multimeter measures the amount of electricity produced.

- Follow the instructions for you multimeter to turn it on and set it to measure up to 20 Volts.
- Make sure that the black probe is plugged in to the V input and the red probe is plugged into the COM input.

Test the voltage of a battery to make sure the multimeter is working properly. To do this:

- Place the red probe on the positive end of the battery and place the black probe on the negative end of the battery.
- If you are testing a 9V battery, the multimeter should measure between 8 and 12 volts.
- If you are testing a D, C, AA, AAA, or AAAA battery, these are all 1.5 volts and the multi-meter should measure between 1.4 and 1.7 volts.
- If you see a negative sign, switch the leads and put them on opposite sides of the battery.

After you have tested your multimeter, turn it off until you are ready to measure the electricity produced by each fruit or vegetable.

Generating Electricity from Fruit

Part Two

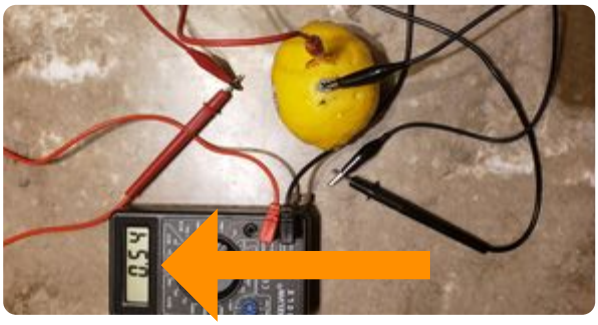
In this part of the experiment, you will build batteries using different produce items. You may use any produce item provided by your teacher, but you may only use one piece of produce at a time. To build the battery, you will use two metal electrodes. One electrode is a penny, which is made of copper. The other electrode is a galvanized screw, which is coated with zinc. These materials mimic the electrodes in a chemical battery.

- Gather a knife, penny, a metal screw, and assorted wires
- Choose a piece of produce from the selection provided by your teacher and bring all materials to your workspace.
- Take your first piece of produce and cut a 1/4“ slice into the flesh.

- Insert the penny into the slit so that only about half the penny is sticking out. Insert the screw about half way into the piece of produce about 1/2“ away from the penny.

- Attach the alligator clip at one end of the red wire to the penny. Attach the alligator clip at one end of the black wire to the screw.

- Record the reading for this piece of produce in the data table. The reading from your multimeter is the voltage.



- Repeat this process to test the other fruits and vegetables and record your results in the data table. Try at least 3 different produce items and record your results for each in the data table.

Generating Electricity from Fruit

Part Three

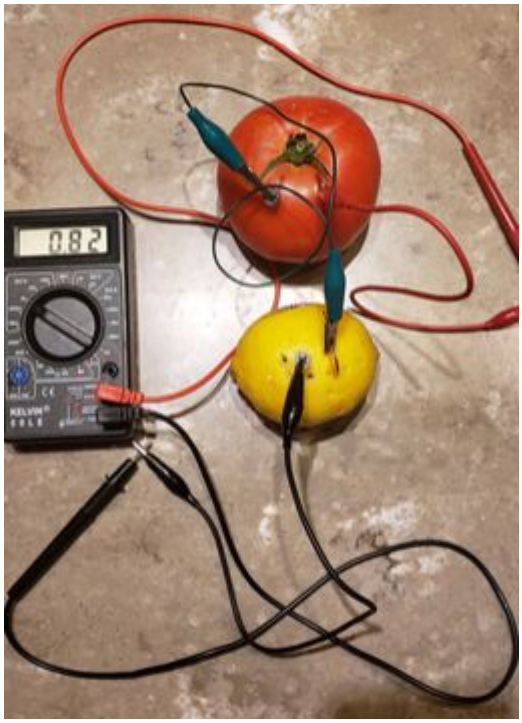
In this part of the experiment, you will test different combinations of produce items to determine how many produce items are required to light a light bulb. A regular LED bulb needs about 1.5 volts of electricity to light. Based on your results from part one of the experiment, you will determine how many produce items are required to generate 1.5 volts of electricity.

Step One

Test a combination of produce items to determine how much voltage they create together.

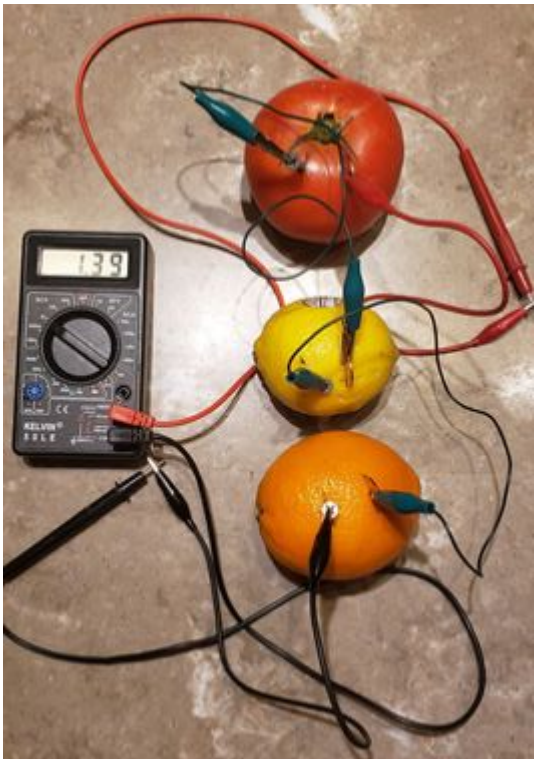
- Choose a combination of two produce items and write their names in the data table.
- Predict the voltage that you expect from the combination.
- Follow the steps from part two and insert a penny and a screw into each type of produce to create a battery.

- Attach wires as follows:
  - Green Wire:
    - Attach the clip on one end of the green wire to the penny on the first produce item.
    - Attach the clip on the other end of the green wire to the screw on the second produce item.
  - Black Wire:
    - Attach the alligator clip at the end of the black wire to the screw in the first produce item.
    - Attach the other end of the black wire to the black probe on the multimeter.
  - Red Wire:
    - Attach the alligator clip at one end of the red wire to the penny in the second produce item.
    - Turn on the multi-meter and attach the alligator clip at the other end of the red wire to the red probe on the multimeter.



- Record the reading for this combination in data table.
- Remove the red and black wires from the screw and penny and prepare to add in additional produce item(s).

- Add produce items to the battery until you get a reading of 1.5 volts or greater.
- To add items:
  - Write the combination you are going to test and predict the results that you expect to get.
  - Insert a penny and a screw into the third produce item to create a battery.
  - Use another set of green wires with alligator clips to connect the produce.
  - Attach the alligator clip on one end of the green wire to the penny on the first produce item.
  - Attach the alligator clip on the other end of the green wire to the screw on the second fruit/vegetable.
  - Turn on the multimeter and reattach the red and black alligator clips to the penny and screw in the first produce item (the produce item that does not have a green alligator clip on it)
  - Record the reading for this combination in the data table.



Step Two

Evaluate your data table to determine which combination of produce items will light the LED bulb.

- To attach the bulb:
  - Use the green wires with alligator clips to attach the produce items together.
  - Use the produce item that DOES NOT have green wires attached to the penny and screw to attach the bulb.
  - Use the red and black wires to attach the penny and screw to the legs of the LED bulb.
- Does your combination light the bulb? Record your results in the data table.

Data Tables

Produce Item						
Voltage						

Produce used in Combination	Predicted number of volts produced	Actual number of volts produced	Did it produce enough to power a lightbulb? (about 1.5 volts)

Teacher Key

Results will vary based on size, age, quality, etc. of produce. Here is a sample of results students might see:

Produce Item	Lemon	Orange	Tomato	Potato	Banana	Apple
Voltage	0.54	0.47	0.29	0.48	0.30	0.39

Voltages from combined foods will create results that will be near, but not exactly equal to the combined voltage of the foods used.

- For example:
  - Lemon + Orange + Tomato = 1.39 volts