Potato Battery: How to Turn Produce into Veggie Power!

Areas of Science	Energy & Power (http://www.sciencebuddies.org/science-fair-projects/project-ideas/energy-power)
Difficulty	
Time Required	Very Short (≤ 1 day)
Prerequisites	None
Material Availability	A kit is available for this project from our partner Home Science Tools (http://www.sciencebuddies.org/store-send?url=https%3a%2f%2fwww.homesciencetools.com%2fproduct%2fpotato-battery-science-kit%3faff%3dSB1).
Cost	Average ($40 - $80)
Safety	Do not eat the potatoes after they have been used as batteries.

Abstract

Imagine telling your friends about your latest science project: using a battery to make a light turn on. You might get some blank stares...sounds a little boring and basic, right? *Now* tell them you will do it with a potato! Yes, you can actually use fruits and vegetables as part of an electric power source! Batteries power many things around you, including cell phones, wireless video game controllers, and smoke detectors. In this science project, you will learn about the basics of battery science and use potatoes to make a simple battery to power a small light and a buzzer.

Objective

Measure how the voltage and current of potato batteries change when you combine them in series or parallel..

Credits

Ben Finio, Ph.D., Science Buddies

Cite This Page

General citation information is provided here. Be sure to check the formatting, including capitalization, for the method you are using and update your citation, as needed.

MLA Style

Science Buddies Staff. "Potato Battery: How to Turn Produce into Veggie Power!" *Science Buddies*, 7 Mar. 2020, https://www.sciencebuddies.org/science-fair-projects/project-ideas/Energy_p010/energy-power/potato-battery. Accessed 1 Apr. 2020.

APA Style

Science Buddies Staff. (2020, March 7). *Potato Battery: How to Turn Produce into Veggie Power!* Retrieved from https://www.sciencebuddies.org/science-fair-projects/project-ideas/Energy_p010/energy-power/potato-battery

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Introduction

Batteries are containers that store energy, which can be used to make electricity. This method of storing energy allows us to make portable electronic devices (imagine what a pain it would be if everything *had* to be plugged into a wall outlet to work!). There are many different types of batteries, but they all depend on some sort of **chemical reaction** to generate electricity. The chemical reaction typically occurs between two pieces of metal, called **electrodes**, and a liquid or paste, called an **electrolyte**. It turns out that the moisture inside a potato works pretty well as an electrolyte, so you just need to add some metal electrodes to a potato, and you have a battery! While you do not need to understand the details of the chemical reaction to do this project, it is explained in technical note at the end of this introduction.

Next, you need to understand some basic concepts about electricity. The flow of electricity is called an electrical **current**, which is measured in a unit called **amperes (A)** (also called **amps** for short). **Voltage**, measured in **volts (V)** is what pushes electrical current through wires. Finally, electrical **resistance**, measured in **ohms (Ω)** (the capital Greek letter Omega) is a measure of how difficult it is for electricity to flow through a certain material. A common analogy for electricity is to imagine water flowing through a pipe. The amount of water flowing is like the current. The pressure pushing the water is like the voltage. The resistance is like the size of the pipe—it is harder to squeeze a lot of water quickly through a very tiny pipe than through a big pipe. Does that seem like a lot to remember? Table 1 summarizes voltage, current, and resistance.

Quantity	Unit	Description
Current	Ampere (A)	The "flow" of electricity
Voltage	Volt (V)	The "pressure" that makes electricity flow
Resistance	Ohm (Ω)	How hard it is for electricity to flow through something

Table 1. Summary of basic electrical terms.

An electrical **circuit** is a path through which the electricity can flow. Circuits can be very complex, with millions and millions of components (like the ones inside your computer), or very simple, with just two components, like a battery and a lightbulb. This project will focus on simple battery-powered circuits. In general, a battery supplies a certain voltage to a circuit. How much current is drawn out of the battery depends on the **load**, or what the battery is connected to.

Batteries have positive and negative **terminals**. In order for electricity to flow in a battery-powered circuit, there must be a complete path from the positive terminal, through the load, and back to the negative terminal. This is called a **closed circuit**. If the path is broken (for example, if one wire is disconnected), electricity cannot flow. This is called an **open circuit**. Finally, if there is a *direct* path from the positive to the negative terminal, this is called a **short circuit**. Short circuits are bad because they can cause batteries to drain very quickly and overheat (luckily, potato batteries can only supply a small amount of current, so short circuits in this experiment are not dangerous). Figure 1 shows diagrams of open, closed, and short circuits.

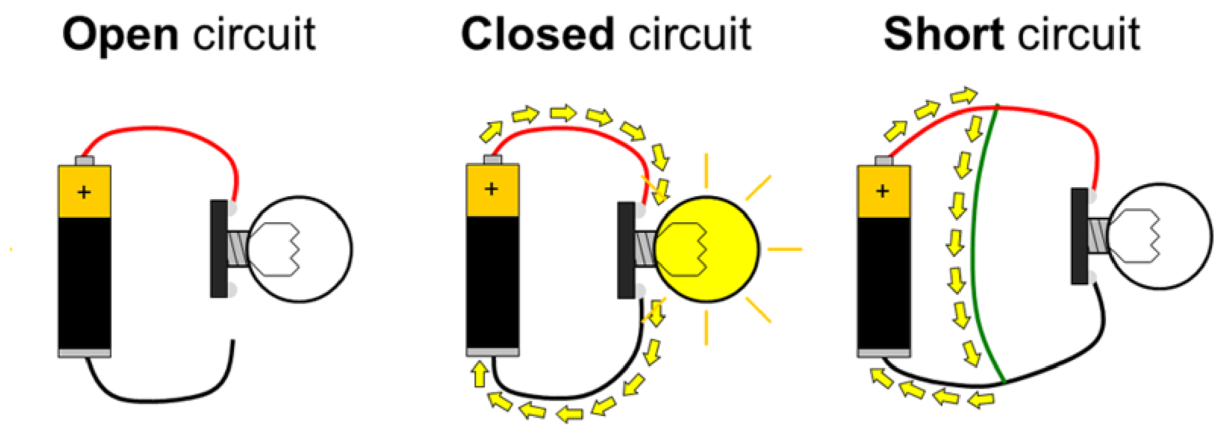

Figure 1. Closed, open, and short circuits. Electrical current is represented by the yellow arrows. In the open circuit, no current flows at all. In the closed circuit, current flows through the lightbulb, causing it to light up. In the short circuit, current flows directly between the battery terminals, bypassing the lightbulb, so it does not light up.

What about circuits that have more than just a single battery? You have probably used many devices that require two or more batteries, like toys or remote controls. Multiple batteries can be connected two different ways: in series or in parallel. When multiple batteries are connected in **series**, the *positive* terminal of one battery is connected to the *negative* terminal of the next battery (and this repeats if there are more than two batteries). When batteries are connected in **parallel**, all of the positive battery terminals are connected together, and all of the negative battery terminals are connected together. These two configurations are shown in Figure 2.

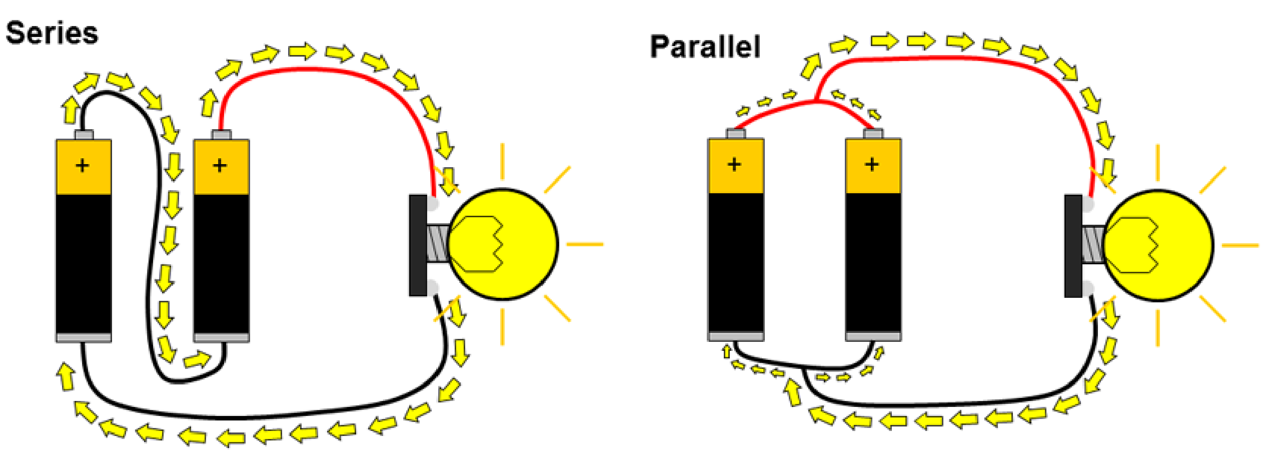

Figure 2. Batteries connected in series and parallel. Electrical current is represented by the yellow arrows.

So why would you choose one method over the other? The amount of voltage and current that can be supplied by multiple batteries changes depending on whether you connect them in series or in parallel, and certain electronic devices might require a certain amount of voltage or current. For example, have you ever noticed how a small device like a TV remote or computer mouse might only require two AAA batteries, but a larger toy or flashlight might require four or more AA batteries? This is because each device has different electrical requirements to operate properly.

You can measure how much voltage or current a certain number of batteries can provide by determining the batteries' open-circuit voltage and short-circuit current. A battery's **open-circuit voltage** is the voltage across a battery's terminals when it is not attached to anything. This is the highest voltage that a battery can supply (the voltage will drop slightly when the battery is attached to a load). The **short-circuit current** is the current when the battery's terminals are shorted together. This is the highest current the battery can supply (the current will also drop when the battery is attached to a load). How exactly do the voltage and current change when your batteries (potatoes) are configured in series or in parallel? In this project, you will use a **multimeter**, a device that can measure electrical circuits, to find out.

Technical Note: Battery Chemistry

In a battery, *chemical* energy is converted into *electrical* energy. In general, electrical current consists of the flow of **electrons**, which are negatively charged particles. In a potato battery, the electrical energy is generated by two chemical reactions that happen at the electrodes (the copper and zinc metal strips). Because copper is more **electronegative** than zinc, it tends to attract electrons more easily than zinc. Therefore, electrons in a potato battery will flow from the zinc electrode, the **anode**, to the copper electrode, the **cathode**. But where do these electrons come from? The electrons are derived from the zinc metal. When zinc is in contact with the electrolyte, the following **oxidation** reaction takes place which results in the release of electrons:

Equation 1 (zinc electrode):

While the the zinc joins the electrolyte as a positive ion (Zn^{++}), the electrons flow through the wire connecting the electrodes (Figure 3 shows an LED connected between the electrodes, but as you will see in the procedure, this could also be a multimeter or a buzzer). Here, positively charged hydrogen atoms, or protons (H^+), that originate from acids inside the potato (phosphoric acid and organic acids), accumulate as they are attracted to the negative charge created by the surplus electrons at the copper electrode. These protons take up the electrons from the copper electrode in a **reduction** reaction to become neutral hydrogen atoms and subsequently form hydrogen gas (H_2) which you might see as bubbles evolving around the copper electrode:

Equation 2 (copper electrode):

This reaction leaves behind a shortage of electrons at the copper electrode, which is the key reason why electrons keep flowing from the zinc to the copper electrode. The battery keeps running until it either runs out of protons if there is not a lot of acid present, or the zinc electrode is "eaten up" and completely dissolved into ions. The overall net reaction in a potato battery can be summarized as:

Equation 3 (net reaction):

(Hydrogen gas and electricity)

Note that the potato itself is *not* the sole energy source for the battery, but functions as an electrolyte to facilitate the transport of relevant ions such as zinc cations and protons that originate from organic acids and phosphoric acid that are present inside the potato.

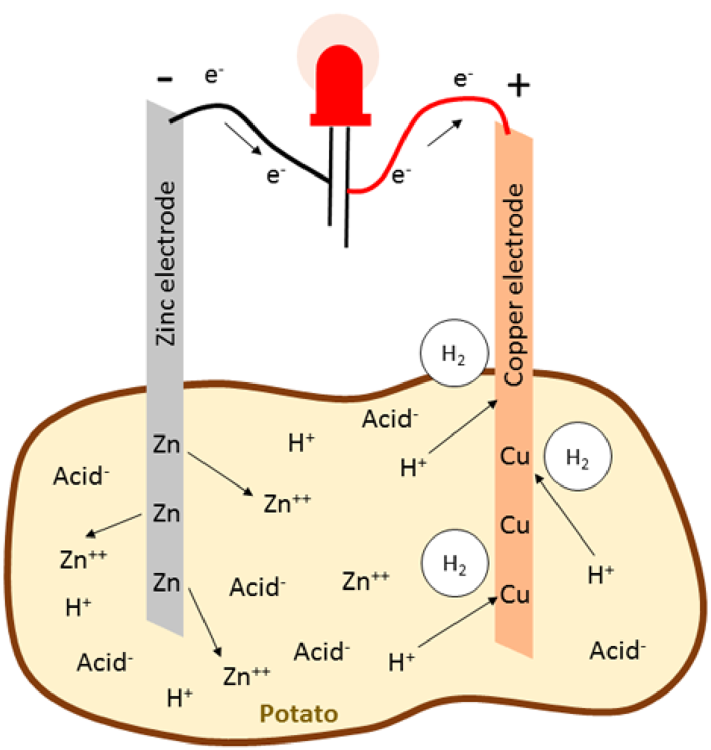

Figure 3. Diagram of the chemical reaction that occurs in a potato battery, with an LED connected between the electrodes. Note that the arrows representing electron movement in this figure point in the opposite direction as those that represent electrical current in Figures 1–2. For more information about sign conventions for electric current, read this technical note (http://www.sciencebuddies.org/science-fair-projects/references/electricity-magnetism-electromagnetism-tutorial#currentelectricity_tech1).

Terms and Concepts

- Battery
- Chemical reaction
- Electrode
- Electrolyte
- Current
- Ampere
- Amp
- Voltage
- Volts
- Resistance
- Ohms
- Circuit
- Load
- Terminal
- Closed circuit
- Open circuit
- Series circuit
- Parallel circuit
- Open-circuit voltage
- Short-circuit current
- Multimeter

Advanced terms:

- Electron
- Electronegative
- Anode
- Cathode
- Oxidation
- Reduction

Questions

- What are the basic parts of a battery? How do batteries generate electrical current?
- What is electrical current? What is its unit of measurement?
- What is electrical voltage? What is its unit of measurement?
- What is electrical resistance? What is its unit of measurement?
- What are the differences between open, closed, and short circuits?
- How is the flow of electricity similar to the flow of water?
- If one vegetable or fruit battery is not enough to power a buzzer, what could you do to resolve the problem?

Bibliography

- Science Buddies. (n.d.). *Electronics Primer: Introduction*. Retrieved June 18th, 2013, from *http://www.sciencebuddies.org/science-fair-projects/project_ideas/Elec_primer-intro.shtml* *(http://www.sciencebuddies.org/science-fair-projects/references/electronics-primer-introduction)*.
- Science Buddies. (n.d.). *Multimeter Tutorial*. Retrieved June 18th, 2013, from *http://www.sciencebuddies.org/science-fair-projects/multimeters-tutorial.shtml* *(http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-multimeter)*.
- The Physics Classroom. (n.d.). *Current Electricity - Chapter Outline*. Retrieved June 18th, 2013, from *http://www.physicsclassroom.com/Class/circuits/* *(http://www.physicsclassroom.com/class/circuits/)*.
- Brain, M., Bryant, C., and Pumphrey, C. (n.d.). *How Batteries Work*. Retrieved June 25th, 2013, from *http://electronics.howstuffworks.com/everyday-tech/battery.htm* *(http://electronics.howstuffworks.com/everyday-tech/battery.htm)*.

For help creating graphs, try this website:

- National Center for Education Statistics, (n.d.). *Create a Graph*. Retrieved June 2, 2009, from *http://nces.ed.gov/nceskids/createagraph/* *(http://nces.ed.gov/nceskids/createagraph/)*

Materials and Equipment

Buy Kit (http://www.sciencebuddies.org/store-send?url=https%3a%2f%2fwww.homesciencetools.com%2fproduct%2fpotato-battery-science-kit%3faff%3dSB1)

- Veggie Power Battery Kit, available from our partner Home Science Tools (http://www.sciencebuddies.org/store-send?url=https%3a%2f%2fwww.homesciencetools.com%2fproduct%2fpotato-battery-science-kit%3faff%3dSB1). Includes:
    - Copper electrodes (3)
    - Zinc electrodes (3)
    - Alligator clip leads (6)
    - Digital multimeter with test leads

- Piezoelectric buzzer
  - Red light-emitting diode (LED) (3)
- You will also need to gather these items, not included in the kit:
  - Potatoes (3), any large type like a russet. Make sure your potatoes are fresh. Old, dried out potatoes will not work well.
  - Ruler
  - Paper towels for cleanup as you prepare the potatoes
  - Lab notebook

Recommended Project Supplies

Get the right supplies — selected and tested to work with this project.

Project Kit: $59.95

Experimental Procedure

1. Insert one copper and one zinc electrode into each of the potatoes, as shown in Figure 4. Use a ruler to make sure you space the electrodes the same distance apart and insert them to the same depth in each potato (for example, 2 cm apart and 3 cm deep. The exact distances you pick may depend on the size of your potatoes).

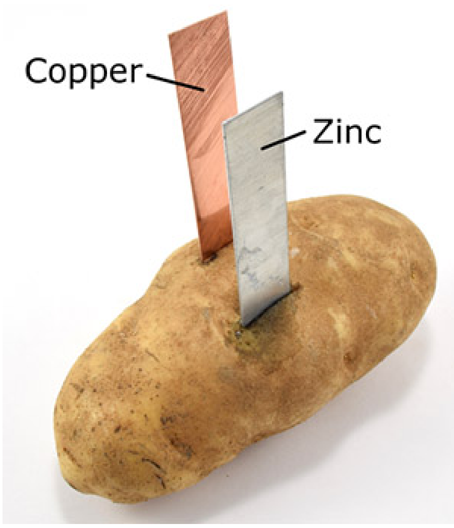

Figure 4. Copper and zinc electrodes inserted into a potato. The copper electrodes are engraved with the letters "CO" and the zinc electrodes are engraved with "ZINC".

2. Prepare a data table like Table 1 in your lab notebook.

	Trial 1					
Series or Parallel	Number of Batteries	Open-circuit Voltage (V)	Short-circuit Current (mA)	Lights the LED (yes/no)	Powers the Buzzer (yes/no)
Series	1*				
	2				
	3				
Parallel	1*				
	2				
	3				

Table 1. Example data table. **Note*: You need two batteries to make a series or parallel circuit. A single battery on its own cannot be "in series" or "in parallel," so the data for these two rows will be the same. Recording it this way just makes it easier to graph your data later.

3. Measure the open-circuit voltage of a single potato battery, as shown in Figure 5. Refer to the Science Buddies resource How to Use a Multimeter (http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-multimeter) if you need help using a multimeter.
    a. Set your multimeter dial to measure in the 20 V range.
    b. Plug the red multimeter probe into the port labeled VΩmA.
    c. Plug the black multimeter probe into the port labeled COM.
    d. Use a green alligator clip to connect the black probe to the zinc electrode.
    e. Use a red alligator clip to connect the red probe to the copper electrode.
    f. Record the voltage in the first row of your data table.
    g. Refer to the Help (#help) section if you get stuck or have trouble taking a reading.

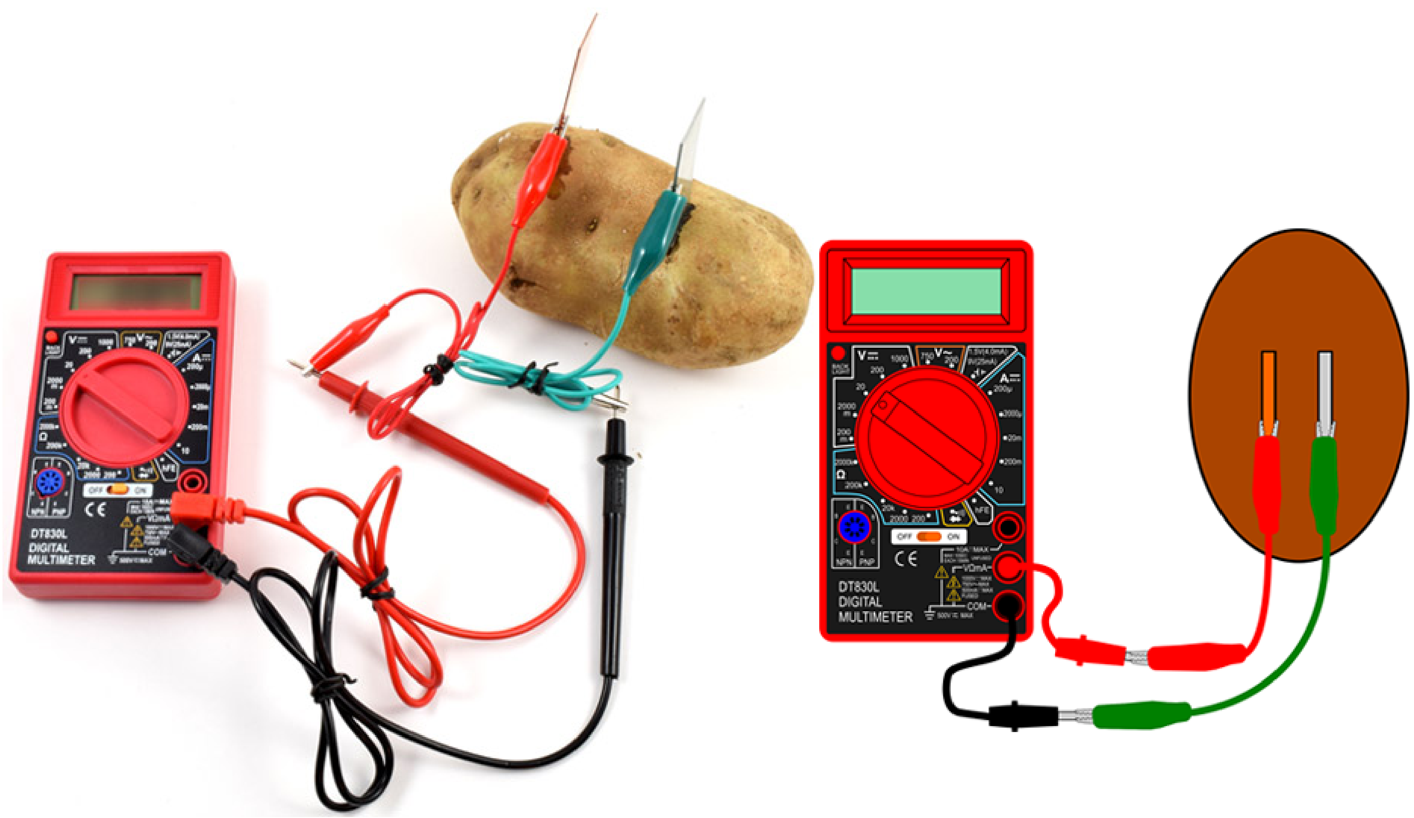

Figure 5. How to set up your multimeter to record the open-circuit voltage. *Note*: The multimeter screen has been blurred in the image on the left. We do not want to give away the data!

4. Measure the short-circuit current, as shown in Figure 6.
    a. Leave the multimeter probes and alligator clips connected as they are.
    b. Change the multimeter dial to measure in the 20 mA range.

c. *Quickly* record the current in your data table. The current will start to drop as the battery begins to drain.

d. **Important**: Do not connect the multimeter to regular batteries (for example AA or 9 V) with these settings. Regular batteries can provide much more current than a potato battery, and can damage your multimeter. Refer to the How do I measure current? (http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-multimeter#qmultimetermeasurecurrent) section of the multimeter resource to learn more about measuring current safely.

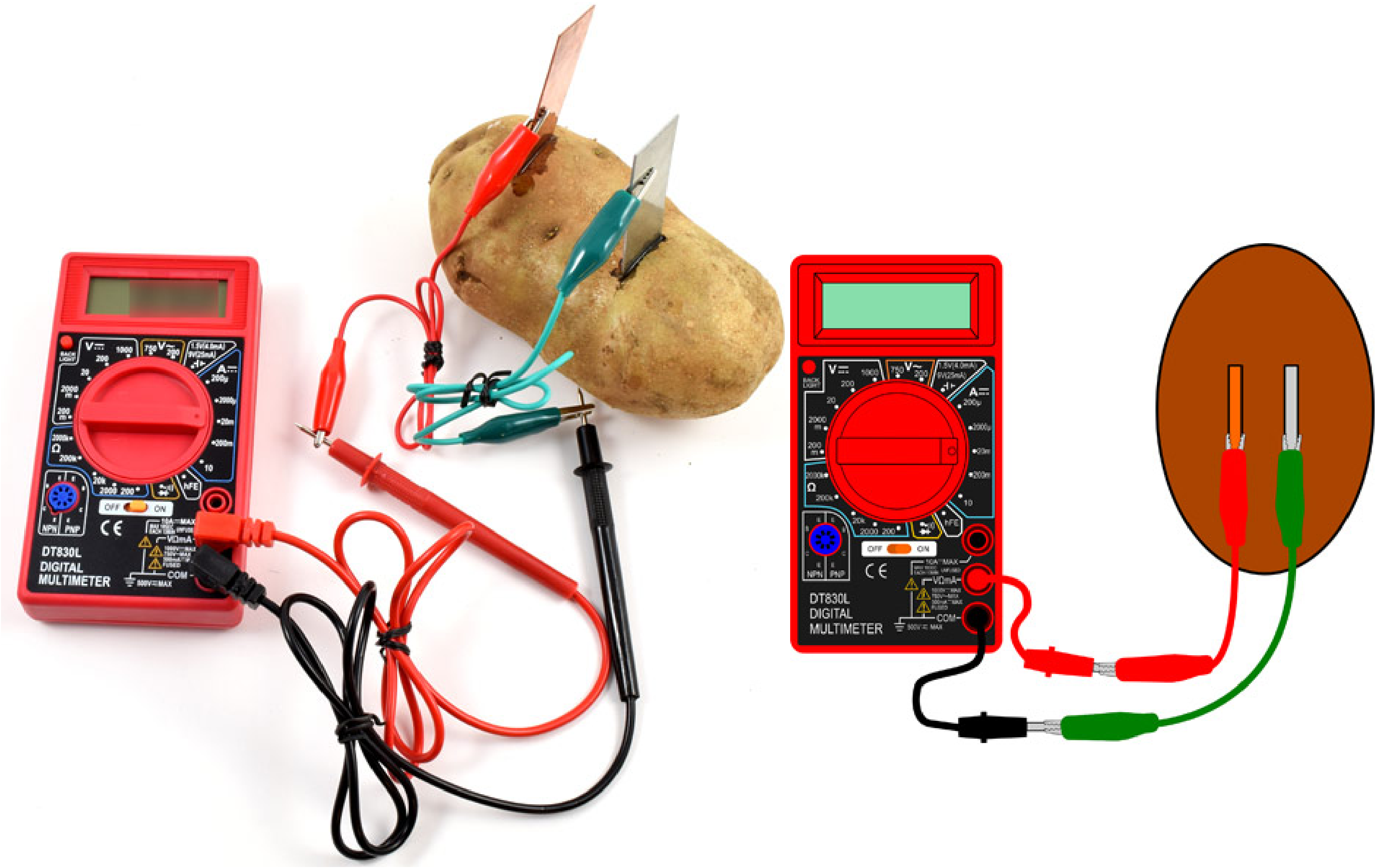

Figure 6. How to set up your multimeter to record the short-circuit current.

5. Test if the potato battery can light up the LED, as shown in Figure 7.
   a. Disconnect the alligator clips from the multimeter probes (leave them connected to the copper and zinc electrodes).
   b. Connect the red alligator clip to the *longer* lead of the LED.
   c. Connect the green alligator clip to the *shorter* lead of the LED.
   d. **Important**: Current can only flow through LEDs in one direction. It is important to connect the copper electrode (positive electrode) to the longer lead of the LED, and the zinc electrode (negative electrode) to the shorter lead. Your LED will never light up if it is connected backwards.
   e. Record in your lab notebook whether or not the LED lights up.

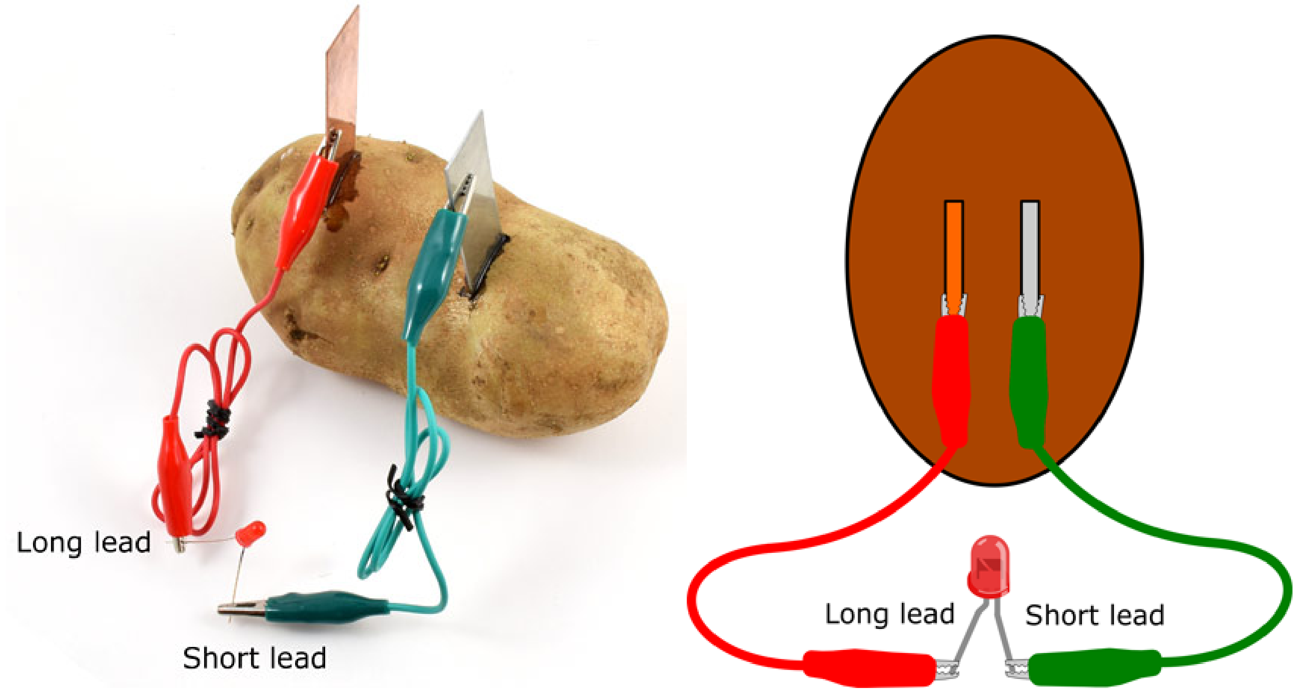

Figure 7. How to connect the LED to your potato battery. Pay attention to how you connect the long and short leads of the LED.

6. Test if the potato battery can power the buzzer, as shown in Figure 8.
   a. Disconnect the alligator clips from the LED.
   b. Connect the red alligator clip to the buzzer's positive (red) wire.
   c. Connect the black alligator clip to the buzzer's negative (black) wire.
   d. **Important**: The buzzer functions similarly to the LED. It has positive and negative pins, and it will not work at all if it is connected backwards.
   e. Record in your lab notebook whether or not you can hear the buzzer.

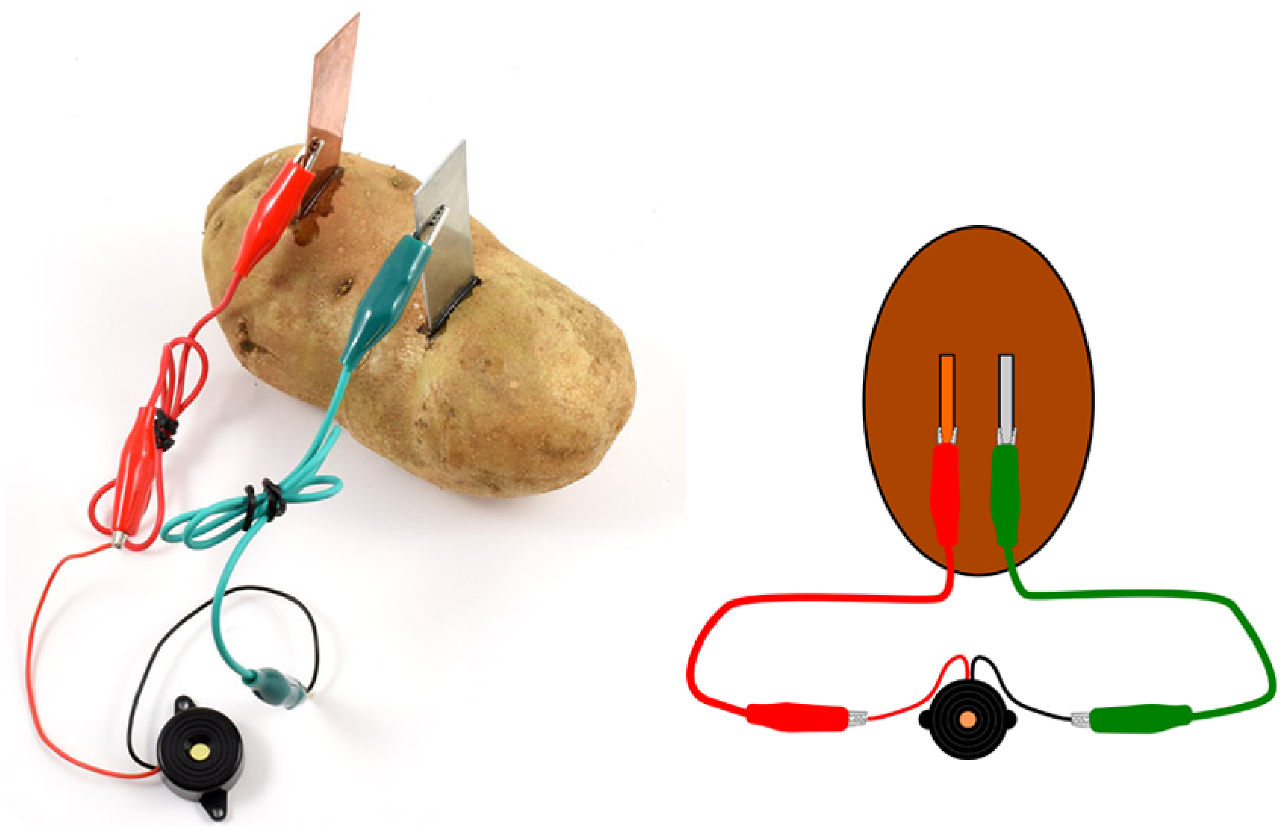

Figure 8. How to connect the buzzer to your potato battery. Pay attention to the positive and negative labels on the pins.

7. Now connect two potato batteries in series, as shown in Figure 9, then repeat steps 3–6.

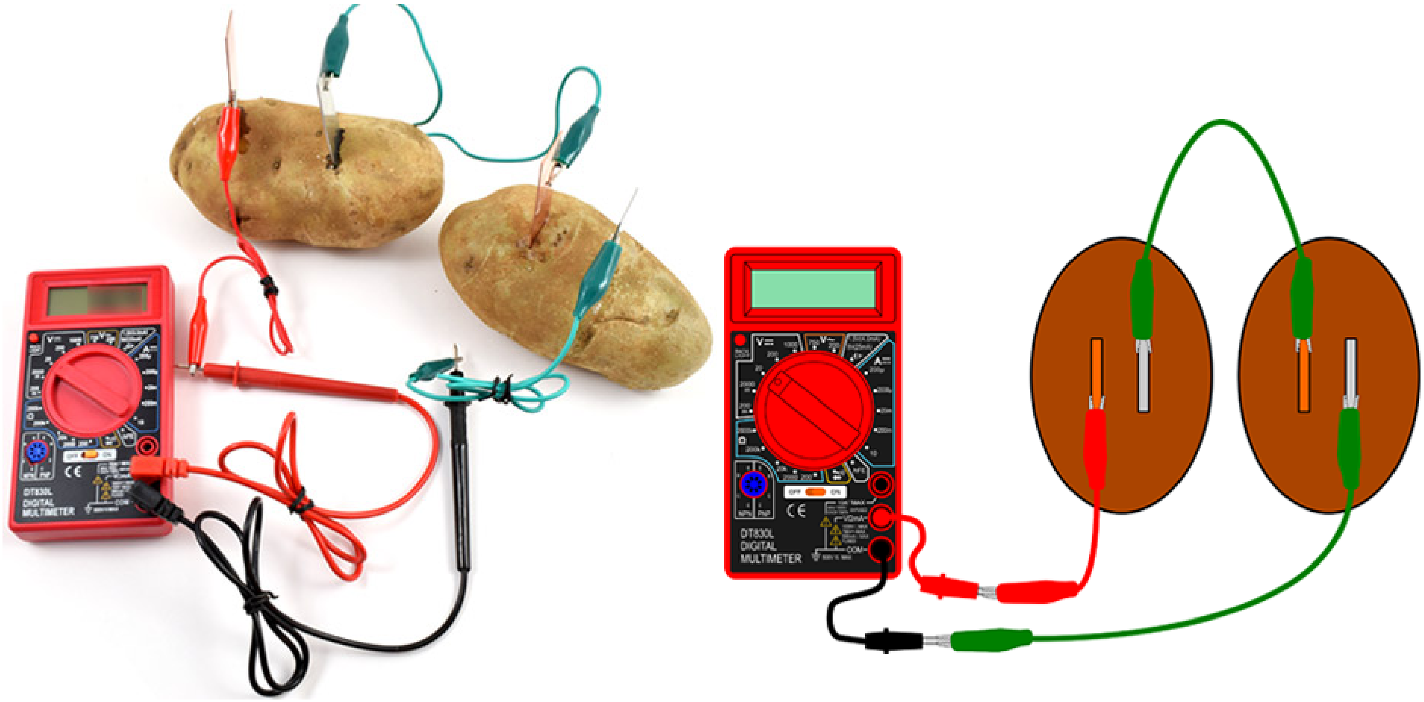

Figure 9. Two potato batteries connected in series. Use an extra alligator clip to connect the zinc electrode of one potato to the copper electrode of the next potato, and move the original green alligator clip to the second zinc electrode. This image shows the multimeter, but you can replace it with the LED and buzzer, as described in steps 5 and 6, respectively.

8. Connect three potato batteries in series, as shown in Figure 10, then repeat steps 3–6.

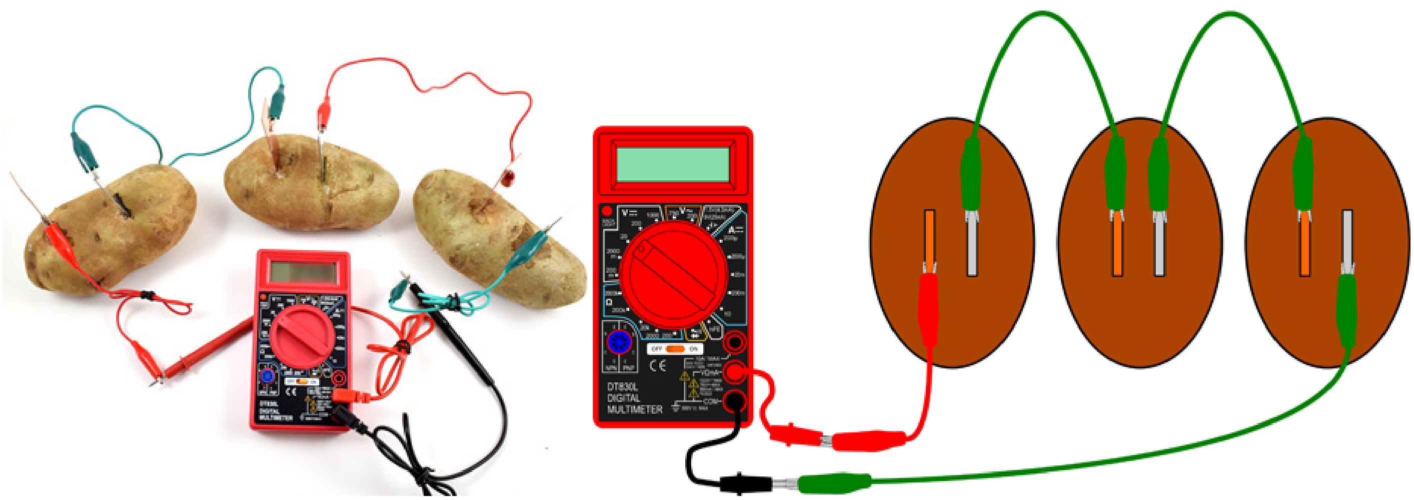

Figure 10. Three potato batteries connected in series. Again, use alligator clips to connect the zinc electrode of one potato to the copper electrode of the next potato, and connect the black multimeter probe to the last zinc electrode using an alligator clip, forming a chain.

9. Copy the data from the first row of your data table (Series - 1 potato) to the fourth row of your data table (Parallel - 1 potato). Remember that you need at least two potatoes to actually make a series or parallel circuit. This just makes it easier to graph your data later.
10. Connect two potato batteries in parallel, as shown in Figure 11, then repeat steps 3–6.

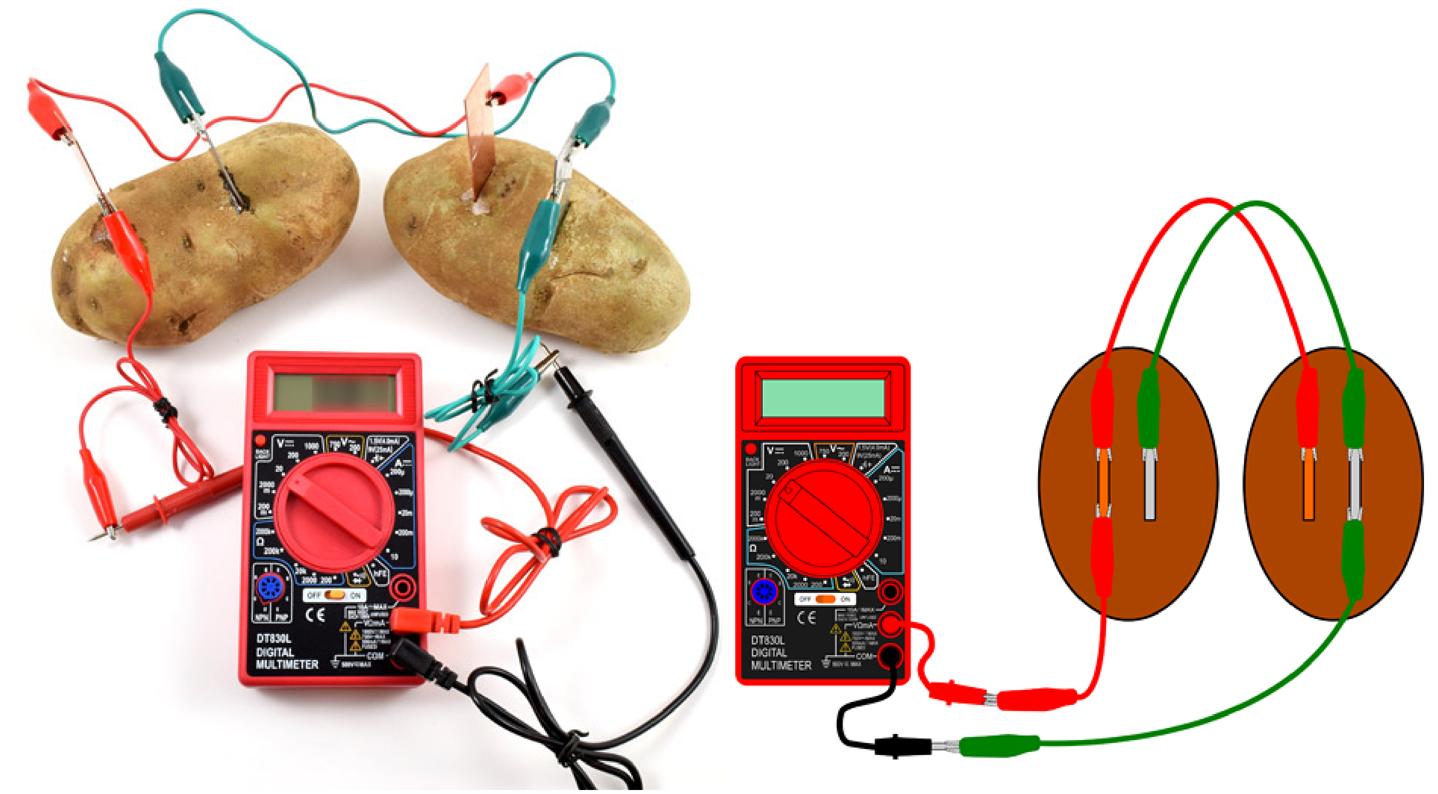

Figure 11. Two potato batteries connected in parallel. Use one extra alligator clip to connect the copper electrodes of both potatoes, and another extra alligator clip to connect their zinc electrodes.

11. Connect three potato batteries in parallel, as shown in Figure 12, then repeat steps 3–6.

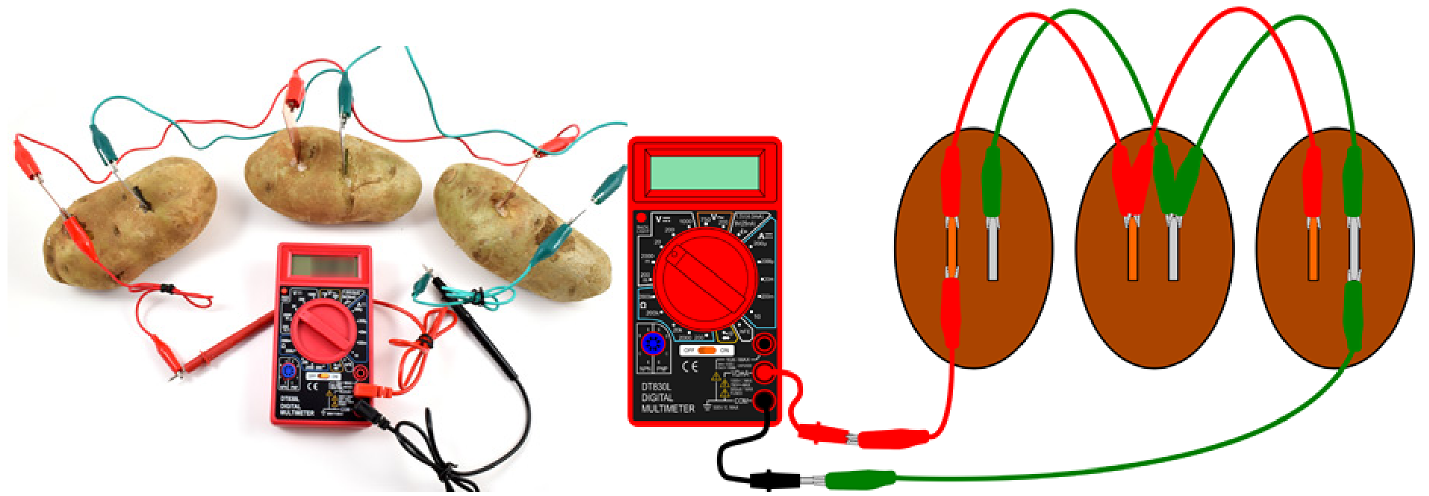

Figure 12. Three potato batteries connected in parallel. Use two alligator clips to connect all of the copper electrodes, and two more alligator clips to connect all the zinc electrodes.

12. Repeat the entire procedure (steps 1–11) two more times, for a total of three trials. Create a new data table for each trial. Remove and re-insert the electrodes into new locations on the potatoes each time. Remember to refer to the Help (#help) section if you have trouble at any point during your experiment.
13. Analyze your data. Refer to the Create a Graph (https://nces.ed.gov/nceskids/createagraph/) if you need help making graphs.
    a. Create a fourth data table for average values. For each configuration (for example, two batteries in series), calculate an average open-circuit voltage and short-circuit current across your three trials. These are the values you will use for your graphs.
    b. Make a line graph of open-circuit voltage vs. number of potatoes. Draw one line for series and one line for parallel. Make sure to include a legend on your graph so you know which is which.
    c. Make a similar graph for short-circuit current.
    d. How do voltage and current change in each graph? Are the lines different for series and parallel connections? Is this what you expected based on your background research?
    e. How much voltage and current does it take to power the LED? Is there a certain voltage or current below which the LED will not turn on?
    f. How much voltage and current does it take to power the buzzer? Is there a certain voltage or current below which the buzzer will not turn on?
14. Cleanup: Dispose of the potatoes in the trash. Do *not* eat the potatoes after using them for this experiment.

Now that you are done with your project, you might be wondering if you can power something bigger than an LED or a buzzer. Can you use a potato battery to power a lightbulb or charge a phone? There are many videos online claiming that you can. Based on your results, do you think those videos are real? If you are not sure, watch this video for more information:

https://www.youtube.com/watch?v=q9X-ez31oiY (https://www.youtube.com/watch?v=q9X-ez31oiY)

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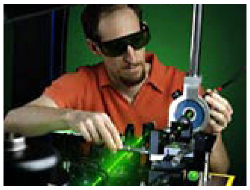
If you like this project, you might enjoy exploring these related careers:



(http://www.sciencebuddies.org/science-engineering-careers/engineering/electrical-electronics-engineer)

Electrical & Electronics Engineer (http://www.sciencebuddies.org/science-engineering-careers/engineering/electrical-electronics-engineer)

Just as a potter forms clay, or a steel worker molds molten steel, electrical and electronics engineers gather and shape electricity and use it to make products that transmit power or transmit information. Electrical and electronics engineers may specialize in one of the millions of products that make or use electricity, like cell phones, electric motors, microwaves, medical instruments, airline navigation system, or handheld games. Read more (http://www.sciencebuddies.org/science-engineering-careers/engineering/electrical-electronics-engineer)

(http://www.sciencebuddies.org/science-engineering-careers/engineering/electrical-engineering-technician)

Electrical Engineering Technician (http://www.sciencebuddies.org/science-engineering-careers/engineering/electrical-engineering-technician)

Electrical engineering technicians help design, test, and manufacture electrical and electronic equipment. These people are part of the team of engineers and research scientists that keep our high-tech world going and moving forward. Read more (http://www.sciencebuddies.org/science-engineering-careers/engineering/electrical-engineering-technician)

(http://www.sciencebuddies.org/science-engineering-careers/earth-physical-sciences/electrician)

Electrician (http://www.sciencebuddies.org/science-engineering-careers/earth-physical-sciences/electrician)

Electricians are the people who bring electricity to our homes, schools, businesses, public spaces, and streets—lighting up our world, keeping the indoor temperature comfortable, and powering TVs, computers, and all sorts of machines that make life better. Electricians install and maintain the wiring and equipment that carries electricity, and they also fix electrical machines. Read more (http://www.sciencebuddies.org/science-engineering-careers/earth-physical-sciences/electrician)

Variations

- Repeat the experiment with different fruits and vegetables, such as apples, onions, oranges, or lemons. How do their open-circuit voltages and short-circuit currents compare to potatoes?
- Hook the battery up to a load (like a resistor, a buzzer, or an LED) and measure its voltage over a long period of time. How long does it take for the battery to drain? Is this time different for the resistor, the buzzer, or the LED?
- "Recharge" a dead potato battery by soaking it in water and repeat the experiment. Investigate how this works. Compare your results.
- Do a new experiment where you change the distance between the copper and zinc electrodes, and measure the effect of this distance on current and voltage.
- Do a new experiment where you change the amount of surface area of the electrodes that is embedded in the potatoes. How does this change the current and voltage? *Hint:* You can fit almost the entire electrode into a potato if you push it in lengthwise.
- Can you find a mathematical formula to predict the voltage and current delivered by combining potatoes in series or in parallel? If so, can you make different combinations, like two batteries in parallel combined with a third battery in series, and test your formulas on these more-complicated scenarios?
- If you were able to power an LED with your veggie battery, try putting two LEDs connected in series, or two LEDs connected in parallel, or a combination of an LED and a buzzer. Do certain combinations work and others not?
- What happens if you do the experiment with smaller (or larger) potatoes, or cut a potato in half? Does that change the amounts of current or voltage that are generated? What about the time it takes for the battery to drain?

Frequently Asked Questions (FAQ)

If you are having trouble with this project, please read the FAQ below. You may find the answer to your question.

Q: Why am I getting negative voltage and current readings?
A: This simply means you either have your multimeter probes or connections to the copper and zinc electrodes switched. Refer to Figure 5 in the Procedure (#procedure). Makes sure the red probe is inserted into the VΩmA port and connected to the copper electrode, and the green probe is inserted into the COM port and connected to the zinc electrode.

Q: I cannot get the LED to light up. What should I do?
A: LEDs require a certain minimum voltage and current to light up. If your LED will not light up, follow the procedure to connect multiple potato batteries in series or parallel. Each combination will increase either the voltage or the current (but it is up to you to take measurements with your multimeter and find out which—we do not want to give the answer away!). However, it is also important to make sure your LED is connected correctly. LEDs only let current flow through them in one direction (this is called "polarity"). So, if you connect your LED backwards, it will *never* light up, even if you have enough voltage and current to power it. Refer to Figure 7 in the Procedure (#procedure) and make sure you pay attention to how you connect the long and short legs of the LED.

Q: I cannot get the buzzer to work. What should I do?
A: Just like the LED, the buzzer requires a certain amount of voltage and current to make noise. If you cannot get the buzzer to buzz, try connecting more potatoes in series or parallel as described in the procedure. As with the LED, the buzzer only lets current flow through it in one direction, and will not work if you connect it backwards. Refer to Figure 8 in the Procedure (#procedure) and pay attention to how you connect the "+" and "-" pins on the buzzer.

Q: I still cannot get the LED or buzzer to work. What is wrong?
A: Make sure you are using firm, fresh potatoes. You can try soaking your potatoes in water to improve their performance, but old, dried-out potatoes may not provide enough power for the buzzer and LED, even if you connect them correctly.

Q: What settings should I use on my multimeter to measure voltage and current?
A: The general rule of thumb for making measurements with a multimeter is to start with the next highest scale above the value you expect to measure. Then, move to a smaller scale if possible to improve measurement accuracy. For this project:

- For voltage, start with the 20 volt (V) scale. If the measured value turns out to be less than 2 V, you can move down to the next lowest scale for improved accuracy. On the DT830L multimeter that comes with the Science Buddies kit, these scales are labeled "20" and "2000m" on the upper left part of the dial. 2000m stands for 2,000 millivolts (mV), which is equal to 2 V.
- For current, start with the 20 milliamp (mA) scale. If the measured current is less than 2 mA, you can move down to the next lowest scale for improved accuracy. On the DT830L multimeter that comes with the Science Buddies kit, these scales are labeled "20m" and "2000μ" on the right side of the dial. 2000μ stands for 2,000 microamps (μA), which is equal to 2 mA.

If you need help using a multimeter or if this is your first time using one, you should ask an adult for help, or refer to the Science Buddies resource How to Use a Multimeter (http://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-multimeter#qmultimetermeasurecurrent).

Q: My multimeter's screen always reads "0.00" when I try to take a measurement. What is wrong?
A: Make sure you have your multimeter set up correctly, as shown in the Procedure (#procedure) starting with Figure 5. The red probe should be plugged into the port labeled VΩmA and the black probe should be plugged into the port labeled COM. You should start out with your dial settings at 20 V for measuring voltage or 20 mA for measuring current. Also make sure that all of your alligator clips are tightly connected to the multimeter probes and electrodes. If a single alligator clip comes loose, that will cause the multimeter to read 0.00.

Q: Can I power a larger device like an MP3 player or cell phone with a potato battery?
A: Unfortunately, many misleading videos on the internet claim that you can charge such devices using just a couple of fruits or vegetables, or even by plugging a USB cable directly into a piece of fruit! These claims have several serious problems.

First, as you probably discovered during your science project, a couple of potatoes can at best produce only a few milliamps of current. Consumer electronic devices like cell phones and MP3 players typically require *hundreds* or *thousands* of milliamps to charge. So, it would take dozens, if not hundreds, of potatoes to produce enough current to charge something like an iPhone.

Second, as explained in the Introduction (#background), in order for a chemical reaction to occur and produce electricity, the electrodes must be two different types of metal. In this experiment, those electrodes are copper and zinc. However, the pins on a USB plug are only *one* type of metal. So, even if a single potato could somehow produce hundreds of milliamps of current, there is no way for a chemical reaction to occur simply by inserting a USB plug. No chemical reaction means no current.

Finally, electronic devices typically require a current and voltage that are well *regulated* in order to charge properly. For example, USB-charging devices are designed to require 5 V, and the current may vary depending on the exact device. Cell phone chargers that plug into a wall are specifically designed to provide the right voltage and current. Not only can hooking up a device directly to an unregulated power supply prevent it from charging properly, but it can also damage or even destroy the battery. So, even if you could somehow get around the first two problems above, it would not be a good idea to charge an electronic device directly from a potato, without some external protective circuitry.

For a further debunking and explanation of this myth, see the HowStuffWorks article Can you power an iPod with an onion? (http://science.howstuffworks.com/innovation/science-questions/onion-power-ipod.htm)

Q: How can I make sure the voltage measurement function on my multimeter is working?
A: Test your multimeter on a normal household battery like a AA, AAA, or 9 V. Set your multimeter to measure 20 V (the "20" in the upper left of the dial). *Important*: Double-check to make sure your multimeter is set to measure voltage, not current. Measuring current in this configuration can damage the multimeter. Plug the black probe into the port labeled COM and the red probe into the port labeled VΩmA. Then, press the multimeter's red probe against the positive (+) end of the battery, and the

black probe against the negative (-) end of the battery. Fresh AA and AAA batteries should produce about 1.5–1.6 V, and a 9 V battery should produce (not surprisingly) about 9 V. If you can successfully measure the voltage of a regular household battery, this means your multimeter's voltage measurement mode is working properly. Refer to the previous steps to look for other problems with your experimental setup. If you are still having trouble with your multimeter, contact service@homesciencetools.com (mailto:service@homesciencetools.com) for assistance.

Q: How can I make sure the current measurement function on my multimeter is working?
A: You can use a simple setup to determine if the current measurement function of your multimeter is working. It will require a 9 V battery, which is not included in your Veggie Power kit.

Your Veggie Power kit should contain a 1,000 ohm, or 1 kilo-ohm (kΩ) resistor; a small, tan-colored cylindrical piece with two metal wires sticking out of it. You can use this resistor to test your multimeter as described here and shown in Figure 13.

1. Set your multimeter to measure current in the 20 mA range (the dial setting labeled "20m" on the right).
2. Plug the multimeter's black probe into the port labeled COM.
3. Plug the multimeter's red probe into the port labeled VΩmA.
4. Use a red alligator clip lead to connect the multimeter's red probe to the positive (+) terminal of the 9 V battery.
5. Use a green alligator clip lead to connect the multimeter's black probe to one of the resistor's leads.
6. Use another green alligator clip lead to connect the resistor's other lead to the 9 V battery's negative (-) terminal.
7. Your multimeter should read about 9 mA (maybe slightly less if you are not using a fresh battery).
    a. If this works, then you know the current measurement function on your multimeter is working. If you are still having trouble with your experiment, the problem is with something else in your setup. For example, you might have your electrodes or alligator clips connected incorrectly to your vegetables. See the other troubleshooting steps for more ideas.
    b. If this does not work, and you are confident that you set up the test correctly as shown in Figure 13, then your multimeter might be defective or have a blown fuse. Please contact service@homesciencetools.com (mailto:service@homesciencetools.com) for assistance.
8. When you are done, disconnect the alligator clips so you do not drain the 9 V battery, and remember to turn your multimeter off.

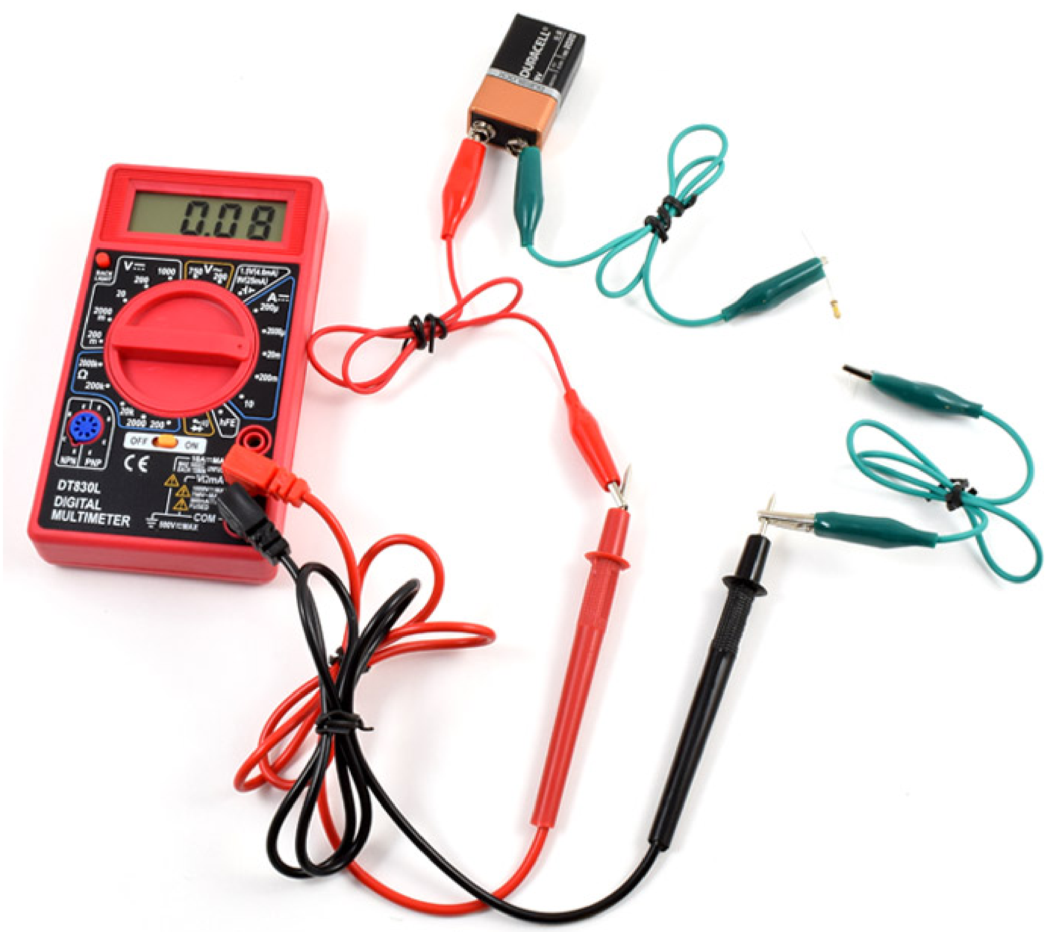


Figure 13. Setup for making sure the multimeter has a working fuse.

Ask an Expert

The Ask an Expert Forum is intended to be a place where students can go to find answers to science questions that they have been unable to find using other resources. If you have specific questions about your science fair project or science fair, our team of volunteer scientists can help. Our Experts won't do the work for you, but they will make suggestions, offer guidance, and help you troubleshoot.

Ask an Expert (http://www.sciencebuddies.org/science-fair-projects/ask_an_expert_intro.shtml)

Contact Us

If you have purchased a kit for this project from Science Buddies, we are pleased to answer any question not addressed by the FAQ above.

In your email, please follow these instructions:

1. What is your Science Buddies kit order number?
2. Please describe how you need help as thoroughly as possible:

   Examples

   Good Question *I'm trying to do Experimental Procedure step #5, "Scrape the insulation from the wire. . ." How do I know when I've scraped enough?*
   Good Question *I'm at Experimental Procedure step #7, "Move the magnet back and forth . . ." and the LED is not lighting up.*
   Bad Question *I don't understand the instructions. Help!*
   Good Question *I am purchasing my materials. Can I substitute a 1N34 diode for the 1N25 diode called for in the material list?*
   Bad Question *Can I use a different part?*

Contact Us (mailto:service@homesciencetools.com?subject=ScienceBuddies:Potato+Battery%3a+How+to+Turn+Produce+into+Veggie+Power!)

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