Potato Battery: How to Turn Produce into Veggie Power!

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Energy_p010/energy-power/potato-battery
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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).

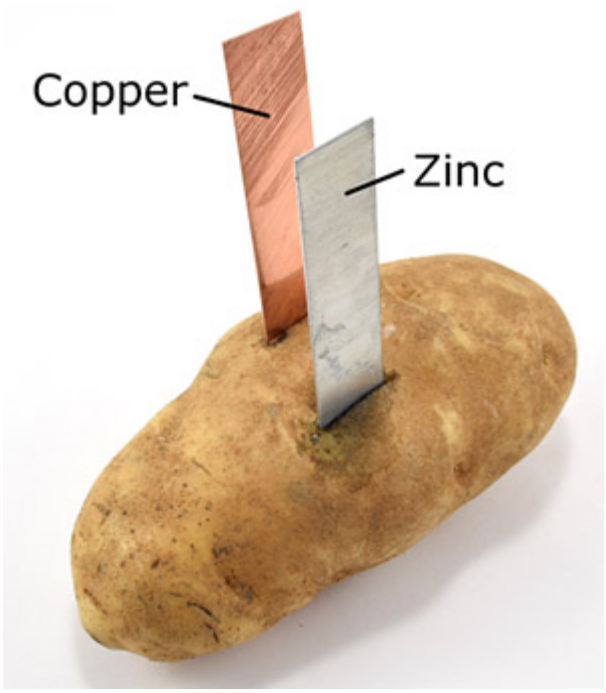


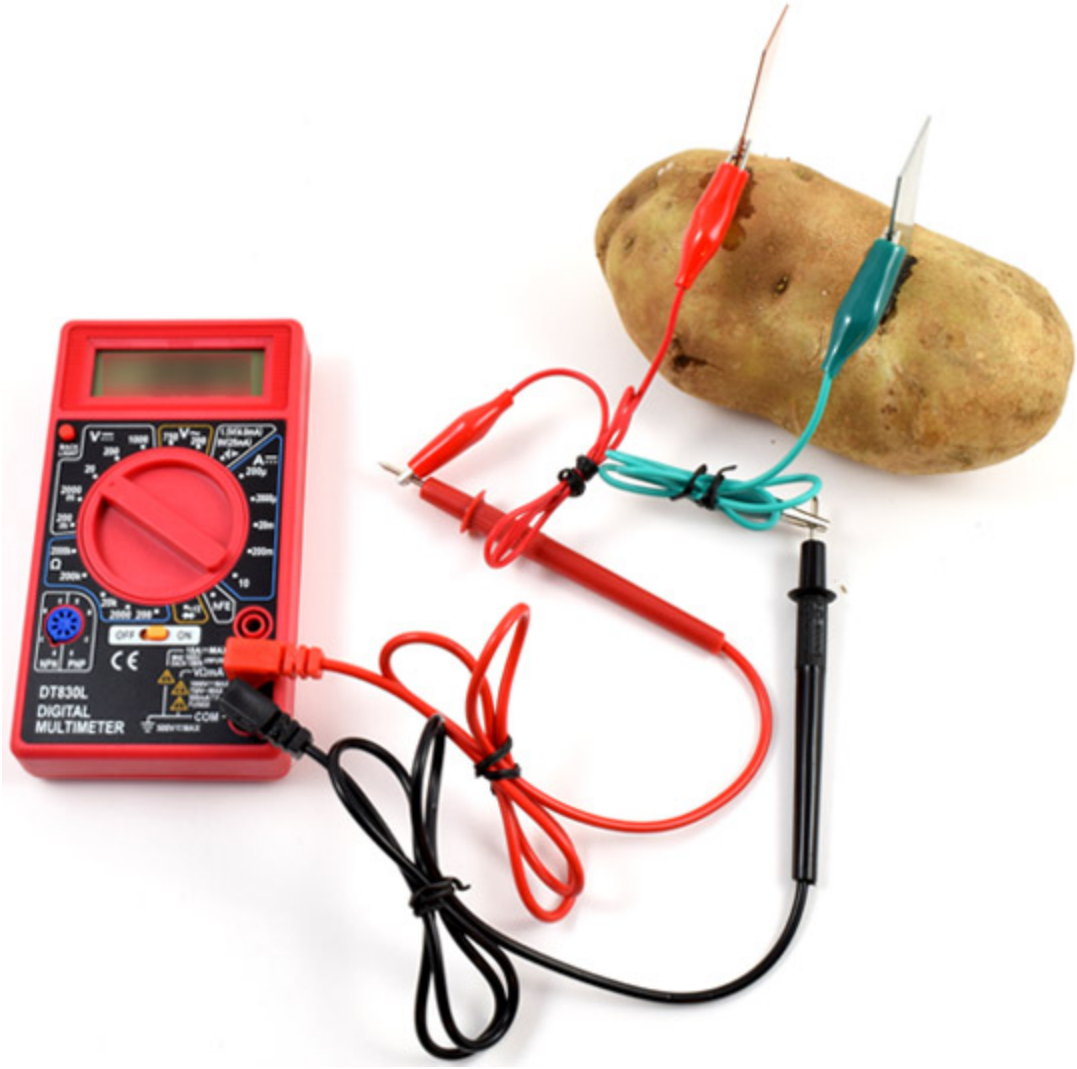
Figure 4. Copper and zinc electrodes inserted into a potato. The copper electrodes are engraved with the letters "CO" and the zinc electrodes are engraved with "ZINC".

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.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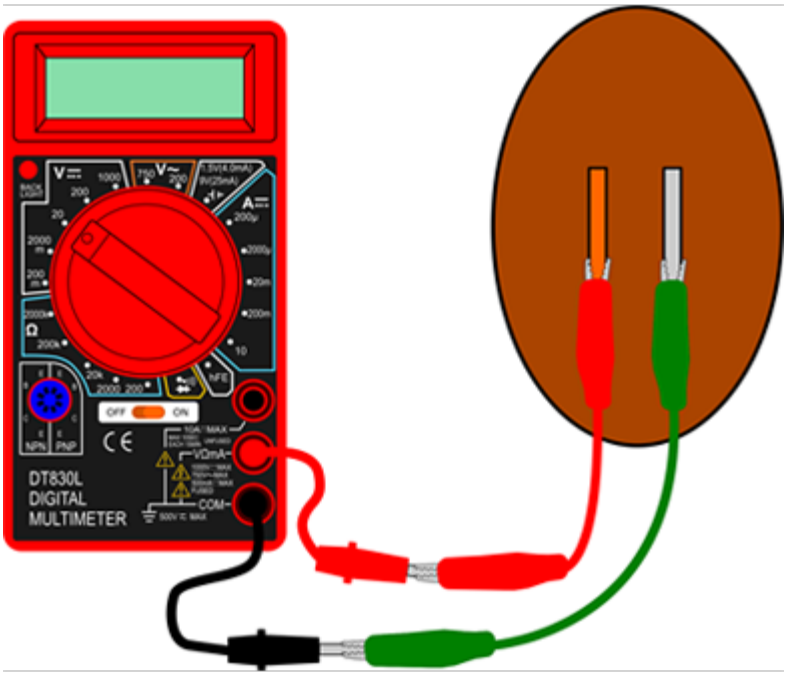
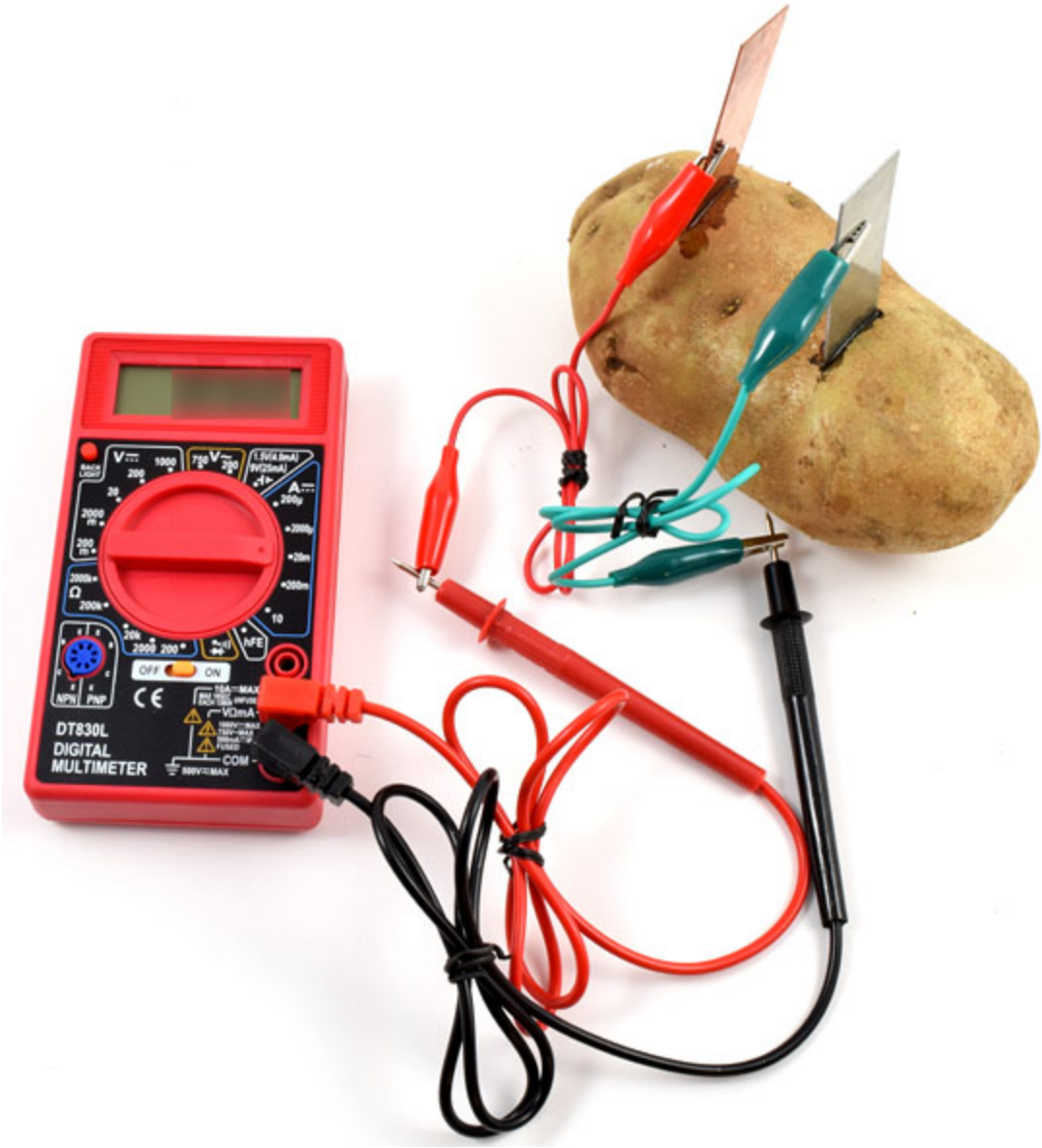


Figure 5. How to set up your multimeter to record the open-circuit voltage. *Note*: The multimeter screen has been blurred in the image on the left. We do not want to give away the data!

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.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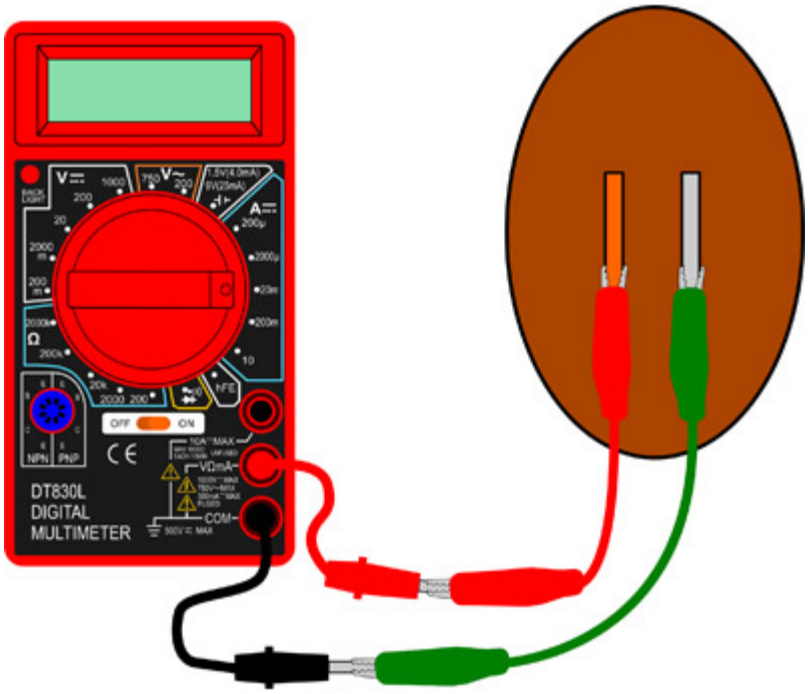


Figure 6. How to set up your multimeter to record the short-circuit current.

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.

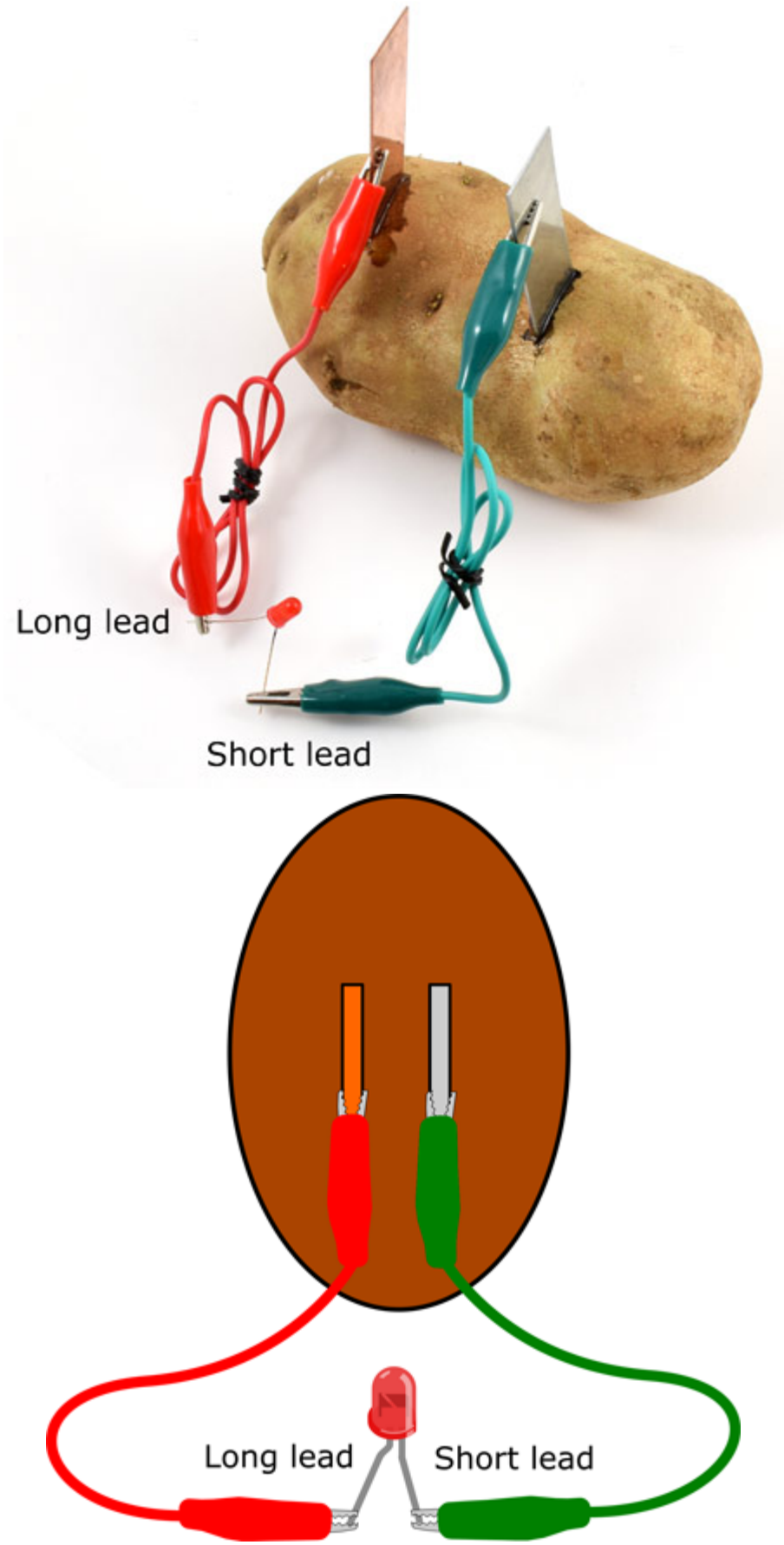
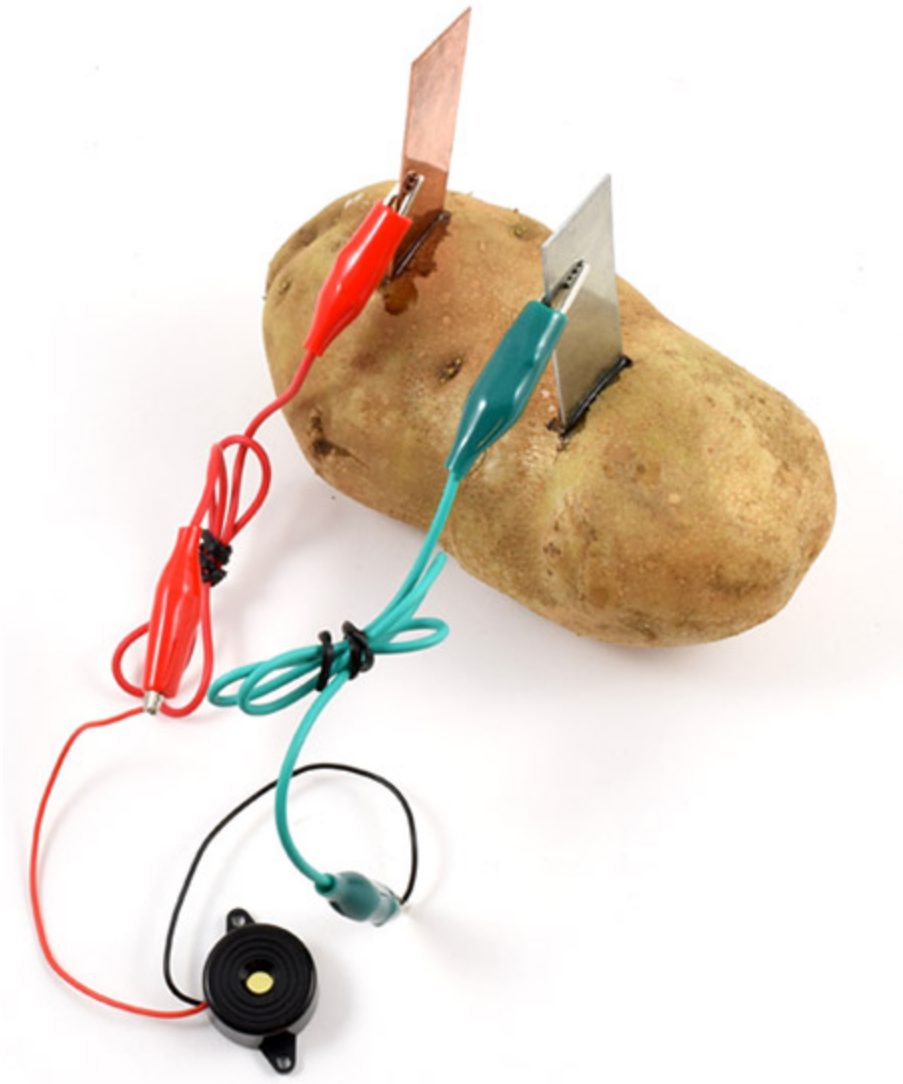


Figure 7. How to connect the LED to your potato battery. Pay attention to how you connect the long and short leads of the LED.

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.



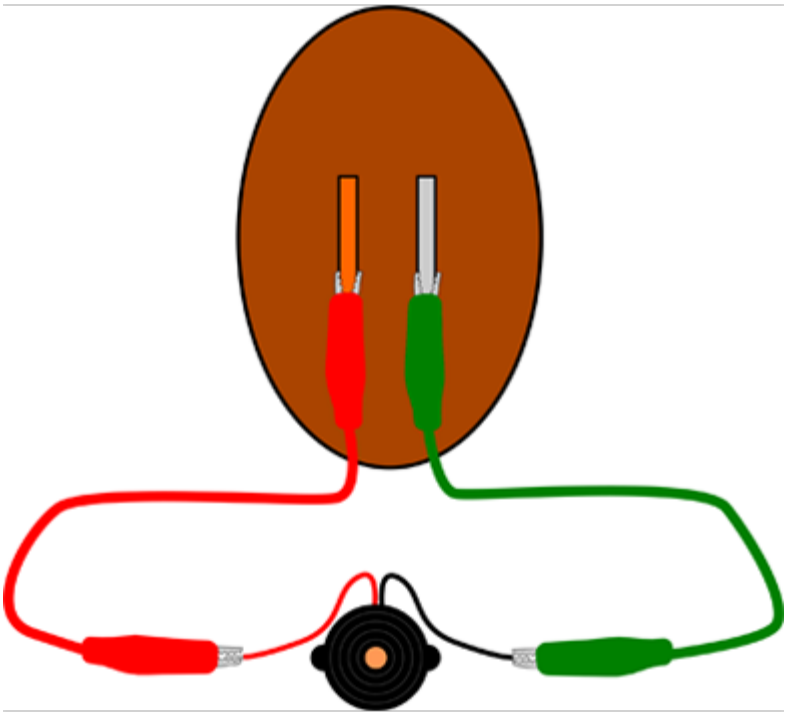
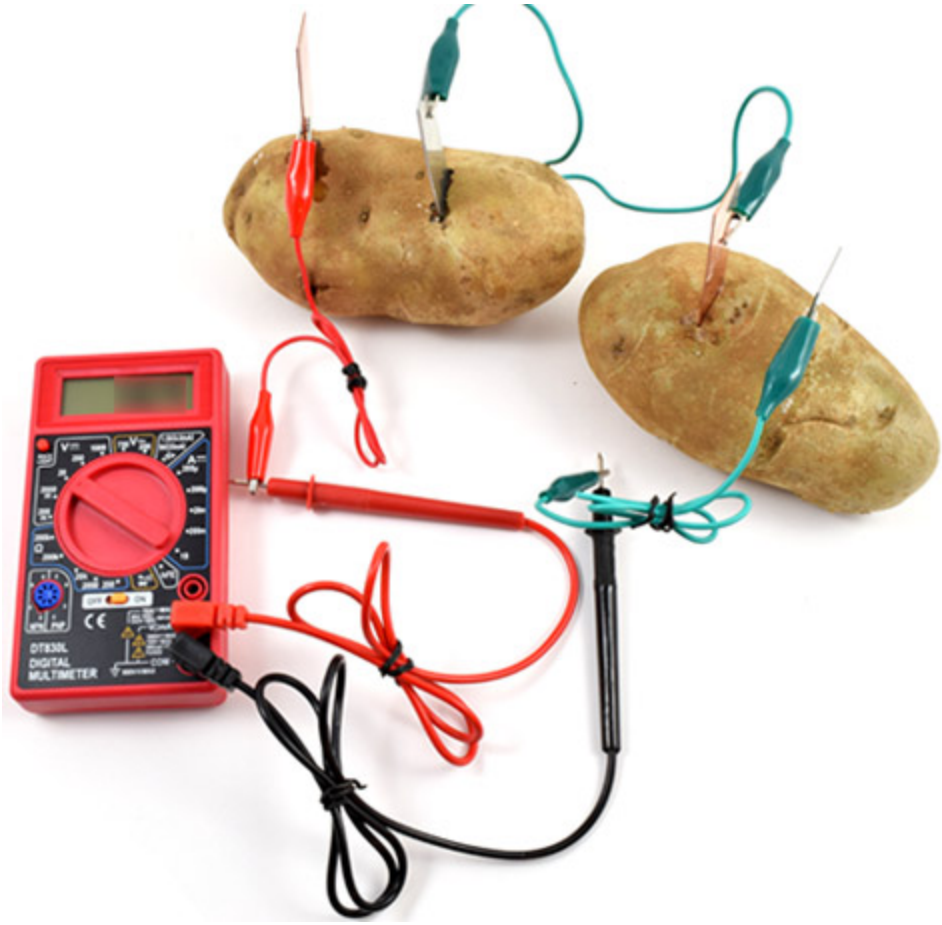


Figure 8. How to connect the buzzer to your potato battery. Pay attention to the positive and negative labels on the pins.

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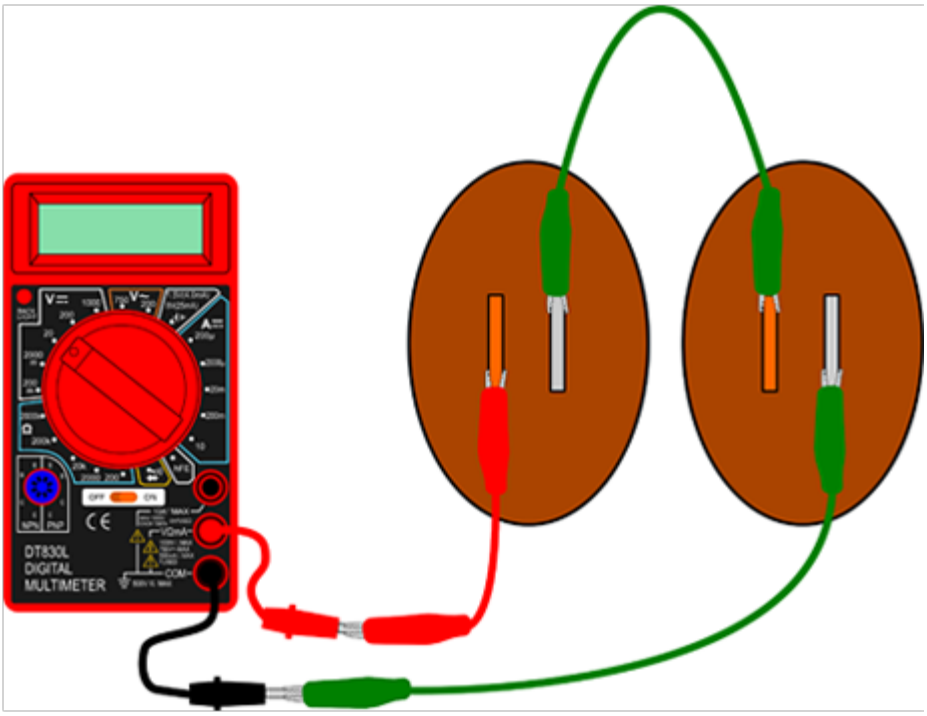

Figure 9. Two potato batteries connected in series. Use an extra alligator clip to connect the zinc electrode of one potato to the copper electrode of the next potato, and move the original green alligator clip to the second zinc electrode. This image shows the multimeter, but you can replace it with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

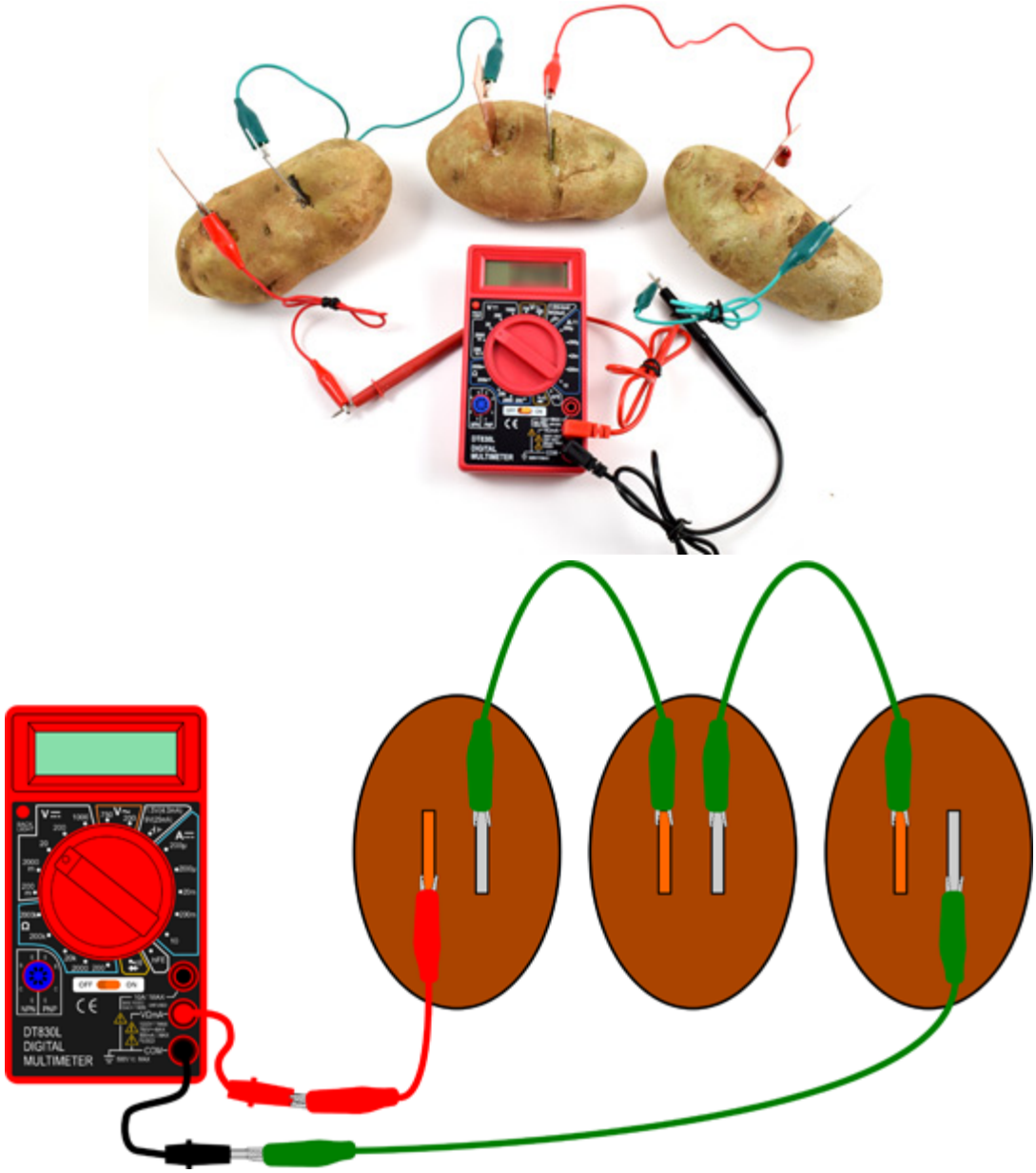

Figure 10. Three potato batteries connected in series. Again, use alligator clips to connect the zinc electrode of one potato to the copper electrode of the next potato, and connect the black multimeter probe to the last zinc electrode using an alligator clip, forming a chain.

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.

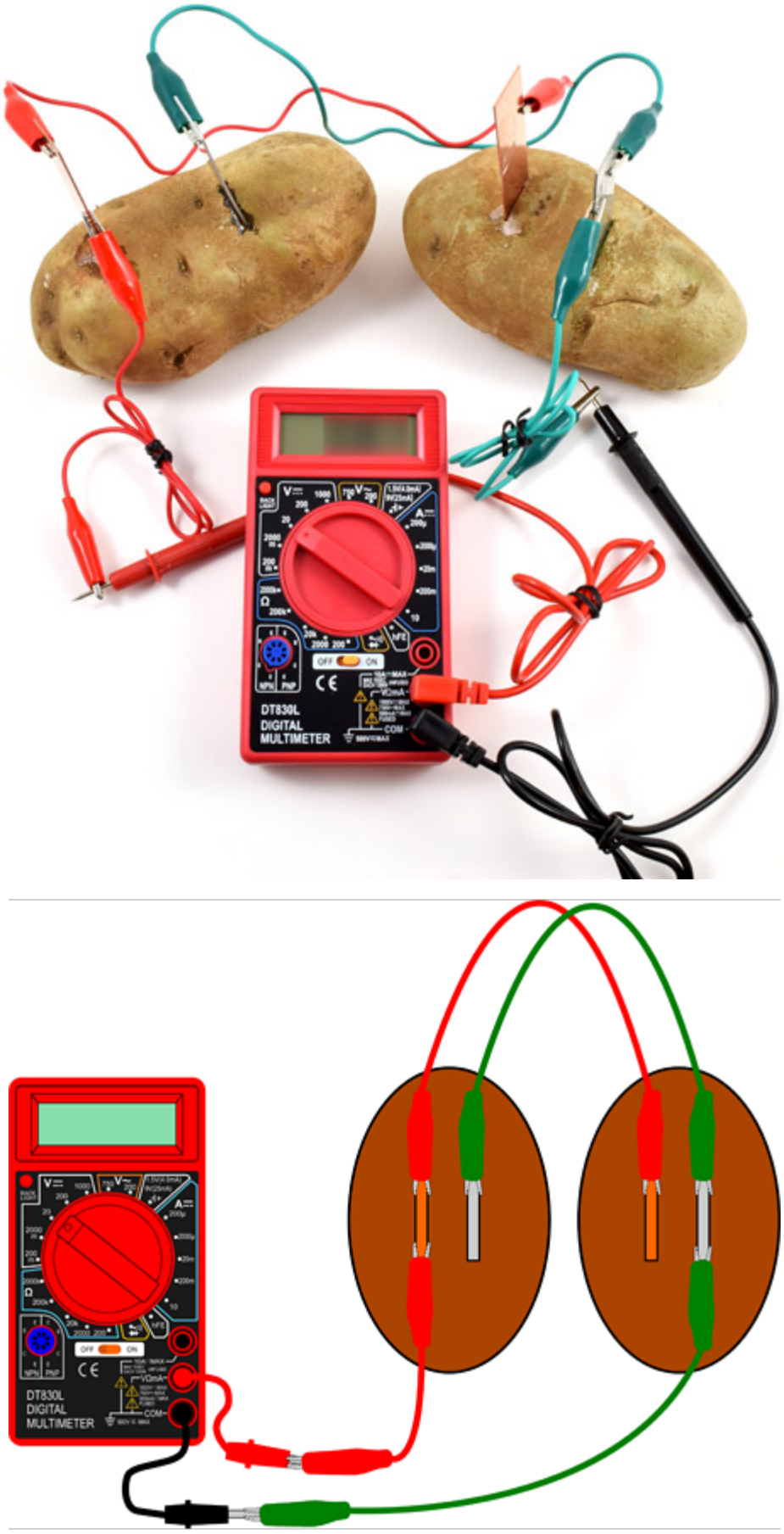

Figure 11. Two potato batteries connected in parallel. Use one extra alligator clip to connect the copper electrodes of both

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.

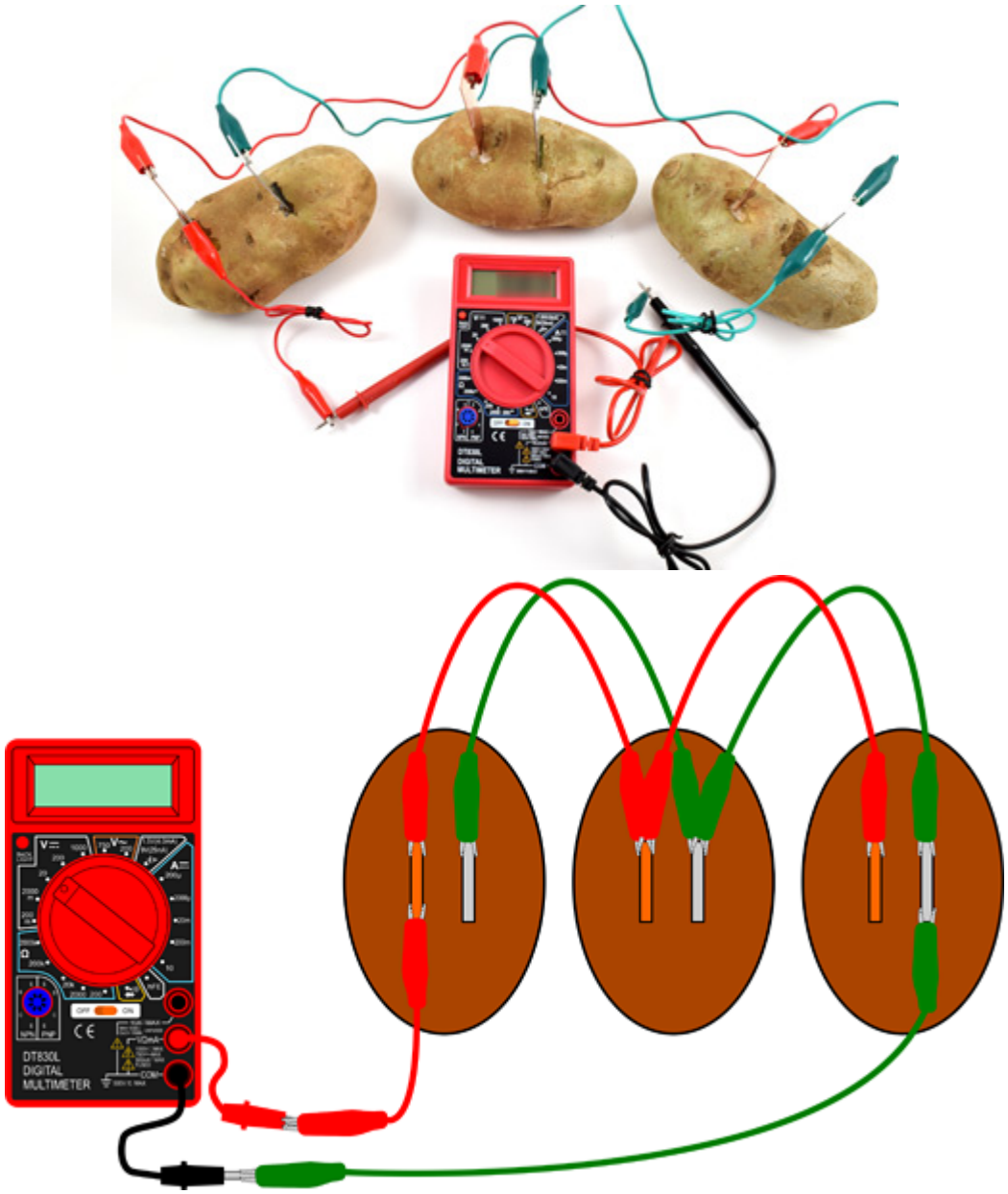

Figure 12. Three potato batteries connected in parallel. Use two alligator clips to connect all of the copper electrodes, and two more alligator clips to connect all the zinc electrodes.

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)

Frequently Asked Questions (FAQ)

FAQ for this Project Idea available online at https://www.sciencebuddies.org/science-fair-projects/project-ideas/Energy_p010/energy-power/potato-battery#help.