NREL
Transforming ENERGY

EXPERIMENTS

Building Series & Parallel Circuits

Questions to ask: What is a circuit? Where else have you heard that word outside of science classes? What shapes do you think of when you think of an electric circuit?

Supplies

- 1 fruit or vegetable with high water content per student (potatoes and lemons work well)
- 4 pennies per student
- 4 galvanized screws per student
- Alligator clip wires
- 1 or 2 voltmeters or multimeters, so teachers can test the voltage of each student's battery

OBJECTIVE

Students will come away from this lesson with a better understanding of **series and parallel circuits**. They will understand what happens to voltage when energy sources are wired in series and parallel with each other. They will be curious about when we use energy sources in parallel versus in series.

Pre-Questions

- Have you ever done a circuit in gym class or sport practice? What did you do?
- Where else have you heard the word series before? Where have you heard the word parallel?

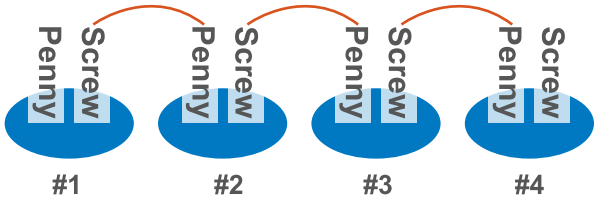
NOTE: To conserve resources, this experiment might be best done as a class demonstration. This experiment tends to be very quick, with the majority of time spent measuring voltage. Remind students to pay attention to each electrode. **The order that you wire the electrodes in matters!**

Experimental Procedure

1. Cut produce into four slices.

2. Insert 1 penny and 1 screw into one slice of the produce. Repeat with other three slices.

3. Line up the slices in a straight line horizontally (see picture below). Label each battery slice with a number 1-4. Take the voltage of each battery slice individually. Record these values in your notebook.



4. Attach an alligator clip of one wire to the screw in the first battery slice. Attach the other end to the penny of the next battery slice. Check the voltage being produced by the two battery slices combined. To do this, touch the voltmeter's red electrode to the penny in the first slice and the voltmeter's black electrode to the screw in the second battery slice. Record the value.

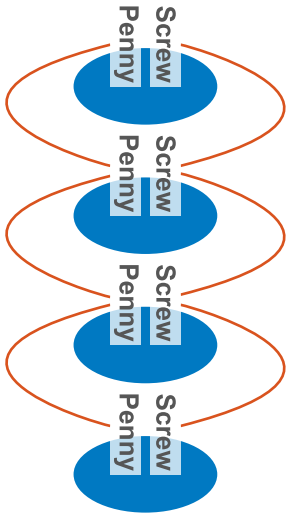
5. Repeat with the screw of the second battery slice and the penny in the third battery slice. Finish by connecting the screw in the third battery slice to the penny of the fourth battery slice (see red "wires" in picture above). Take the voltage of the entire system. To do this, touch the voltmeter's red electrode to the penny in the first slice and the voltmeter's black electrode to the screw in the fourth battery slice. Record the value.

6. Take the voltage reading from battery slice #2 to battery slice #3. To do this, touch the voltmeter's red electrode to the penny in the second slice and the voltmeter's black electrode to the screw in the third battery slice. Record the value.

7. Disconnect the battery slices from one another.

These batteries are wired in series. What happened to the total voltage? Is it bigger? Is it smaller? Did it change?

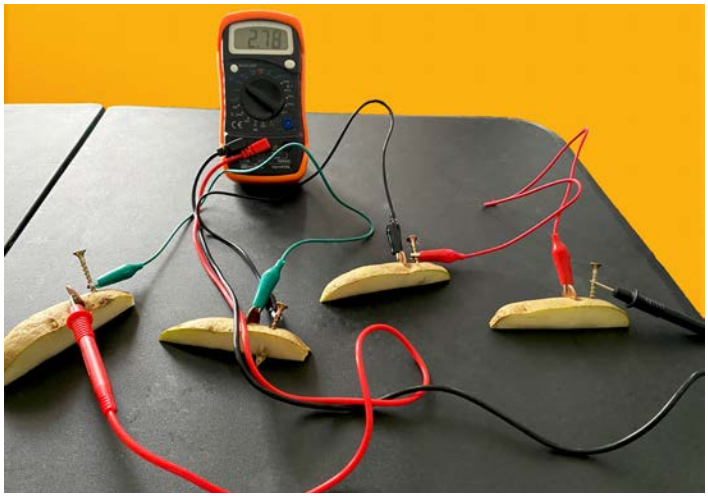
a. Line up the battery slices in a straight line vertically (see picture below).



2. Connect an alligator clip of one wire to the penny in the first battery slice. Connect the other end to a penny in the second battery slice. Take a different wire. Connect one end to the screw in the first battery slice to the screw in the second battery slice. Take a voltage reading. To do this, touch the

voltmeter's red electrode to the penny in the first slice and the voltmeter's black electrode to the screw in the second battery slice. Record the value.

c. Connect the rest of the battery slices the same way. Connect one end of a wire to the penny in the second battery slice (it will have two alligator clips on it) and the other end to the penny in the third battery slice. Connect one end of a new wire to the penny in the third battery slice and the other end to the penny in the fourth battery slice. Repeat this with the screws.



d. Your battery pack should resemble the above picture. Take the voltage of the entire battery pack. To do this, touch the voltmeter's red electrode to the penny in the first slice and the voltmeter's black electrode to the screw in the fourth battery slice. Record the value.

These batteries are wired in parallel. What happened to the total voltage? Is it bigger? Is it smaller? Did it change? Why do you think we call this a parallel circuit?

Post-Questions

- Which combination produced the largest voltage?
- Which combination produced the lowest voltage?
- What would happen if we had the same metal for both electrodes?

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NREL/FS-6A42-82713 • April 2022