



EXPERIMENTS



Combining Energy Sources

Questions to ask: What energy sources do students use every day (batteries, plugs, food, lights, oven/microwaves, etc.)? Could humans survive with only one energy source? Can you plug a human into recharge? Can an oven run off of plants?



Supplies

- 1 fruit or vegetable with high water content per student (potatoes and lemons work well)
- 10 wires with alligator clips per student
- 4 pennies per student
- 4 galvanized screws per student
- 1 or 2 voltmeters or multimeters, so teachers can test the voltage of each student's battery
- 1 solar panel per student
- 1 CR2032 battery per student
- 1 hand crank generator (for teacher use)
- 1 motor per student
- 1 gear hub per student

OBJECTIVE

Students will come away from this lesson with an understanding that the **future of the energy grid will rely on multiple energy sources**. They will be excited about what they can power with their new voltage limits.



Pre-Questions

- What did you have for dinner last night? If you are going to do an activity that requires more energy, would you eat differently?
- Do you think it is a good idea or bad idea to rely on one source of energy? Why might it be good? Why might it be bad?

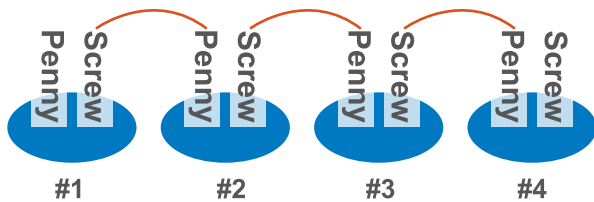
NOTE: Remind students to pay attention to each electrode. **The order that you wire the electrodes in matters!**





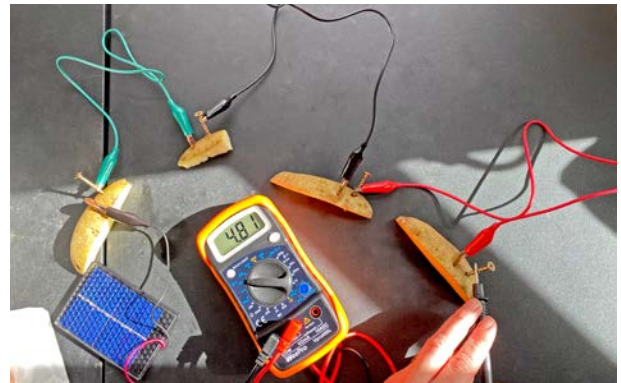
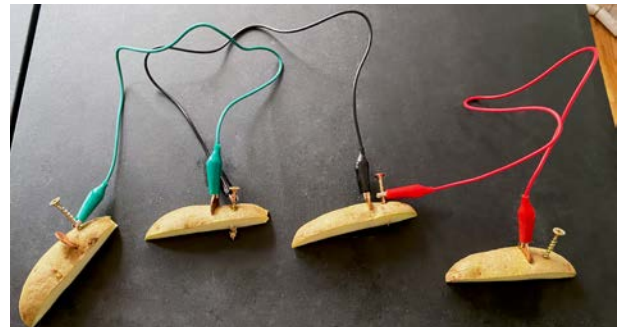
Experimental Procedure

1. Choose two energy sources to pair with the produce battery cells.
2. Cut produce into four slices.
3. Insert 1 penny and 1 screw into one slice of the produce. Repeat with other three slices.
4. 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.



5. 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.
6. 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.

7. 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.
8. Wire in your extra energy source. In our example, we have chosen the solar panel. Make sure you wire in the extra source negative → positive.



9. Take the voltage of the whole system.



Post-Questions

- What were some things you noticed about your voltmeter?
- Did the number stay the same or did it bounce around?