Electric Circuits

Goals

- Build a complete circuit with a solar panel
- Power a motor and electrolyzer with a solar panel
- Measure voltage and amperage in different circuits

Background

Electricity has fundamentally changed the history of humanity. Steam may have powered the industrial age, but electricity has powered every age since. It would be impossible to eat, work, travel, communicate, or create music or art like we do today without electricity.

Electricity is nothing more than the movement of electrons. Within the right materials, called conductors, electrons are no longer attached to single atoms but can move freely between them. Metals are the best conductors, and copper is one of the best conducting metals. Silver is even better, but it's much more expensive, so most electrical wires are made of copper.

For an electric current to move through wires, though, it needs to be pumped. Just like water through a pipe, there must be pressure that pushes the electrons in one direction or the other. We could fill a pipe with water, just as the copper atoms still have their electrons all around them, but without a pressure to move them they won't go anywhere. In electrical circuits, we call this pressure a voltage. Voltage is measured in volts.

When a voltage is applied to an electric circuit, electrons begin to move in one direction. This produces an electric current. We measure current, the amount of moving electrons, in amperes or amps for short. Some electric current moves in just one direction, and we call that direct current (DC). Other currents move back and forth very quickly, many times a second, and we call that alternating current (AC).

There are two ways that two or more devices can be hooked up to an electric current: in series and in parallel. When devices are attached in series, there's only one complete circuit and the devices are attached next to each other like lights on a Christmas tree. (See Fig. 1)

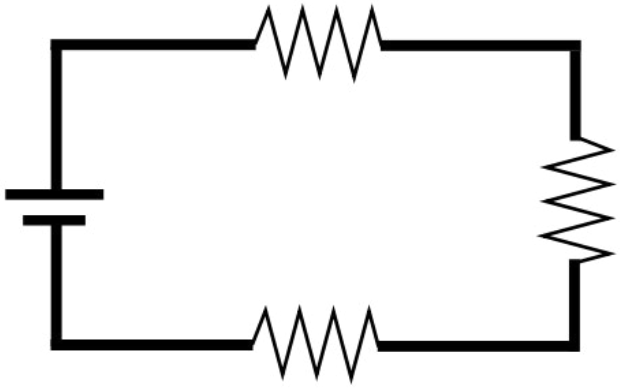

Fig. 1 Series circuit (with 3 resistors)

When devices are attached in parallel, the circuit splits current to each individual device and reconnects to the power source. (Fig. 2)

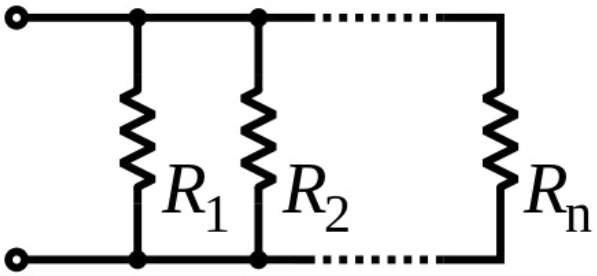

Fig. 2 Parallel circuit (of n resistors)

During this activity, we will use a solar panel to generate DC electricity, see how we can change the amount of current it produces, and attach devices to the circuit in series and in parallel.

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Procedure

1. Use your solar cell to power the small motor that controls the fan. You'll need to connect the solar cell to the fan using wires to carry the electricity. Why do you think you need two wires?
2. When you've connected the solar cell to the motor, you may have to give the fan a little push to get it started. The solar cell will work best in direct sunlight. What happens to the fan if you try the solar cell with other light sources?
3. You can use the electricity from the solar panel to generate hydrogen gas using the electrolyzer. The electrolyzer is the square with "H2" and "O2" printed on either side. What do you think will happen if you connect it to a source of electricity like the solar cell?
4. Your electrolyzer is also a hydrogen fuel cell that can generate electricity from hydrogen and oxygen. It has two small tubes attached to it. Is there anywhere else on the fuel cell that you could attach the longer tubes?
5. Look at the remaining pieces of your kit. If the fuel cell splits water into hydrogen and oxygen gases, what could you use to trap the gases so they don't float away?
6. Connect the tubes of your fuel cell so that you can trap the gases. To generate hydrogen, you'll need to supply an electric current. You can do this with the battery pack or the solar cell. Try both. Which is better at producing hydrogen? How do you know?
7. When you've produced hydrogen, you can use the fuel cell to power the motor just like you did with the solar cell. Plug the motor into the fuel cell and it should start turning. Note in your observations if you see any difference in how the motor works with the fuel cell instead of the solar cell.

Observations

Experimentation

1. With the motor attached, try tilting the solar panel so that it changes the angle of the light that hits it. Can you tilt it far enough that the motor stops running? Does it matter which direction you tilt the panel? Using a protractor, measure the biggest angle at which you can still run the motor.

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2. Attach both the motor and electrolyzer to the solar panel in series and record your observations below:

3. Now attach them both in parallel. How can you split the electricity between the two devices? How does their performance compare to when they were attached in series? Record your observations below:

Measurement

For this section, you will need a multimeter or the Horizon Renewable Energy Monitor. For an introduction to using a multimeter, click here.

1. Measure the current in Amps and the voltage in Volts while running the motor. Record your answers below:

Current: _____ A

Voltage: _____ V

2. Measure the current in Amps and the voltage in Volts while running the motor and electrolyzer in series. Record your answers below:

Current: _____ A

Voltage: _____ V

3. Voltage is equal to the current multiplied by the resistance (V = IR), so according to your data what is the combined resistance in ohms of the electrolyzer and motor?

Resistance: _____ Ω

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4. Measure the current in Amps and the voltage in Volts while running the motor and electrolyzer in parallel. Record your answers below:

Current: _____ A

Voltage: _____ V

Analysis

1. Make a scientific claim about what you observed while using your circuits.

2. What evidence do you have to back up your scientific claim?

3. What reasoning did you use to support your claim?

4. Use your observations to design an experiment you could run to increase the amount of electricity generated by the solar panel. Describe your experiment below.

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Conclusions

1. Based on your observations did the electrolyzer and motor get more electric current when they were hooked up in series or in parallel? How do you know?

2. Does hooking up more devices to an electrical circuit in series increase or decrease the electric current in the circuit? Explain your answer.

3. Which is the best way to attach both the motor and electrolyzer with the solar cell at the same time: series or parallel? Explain your answer.