

### What's it all About?

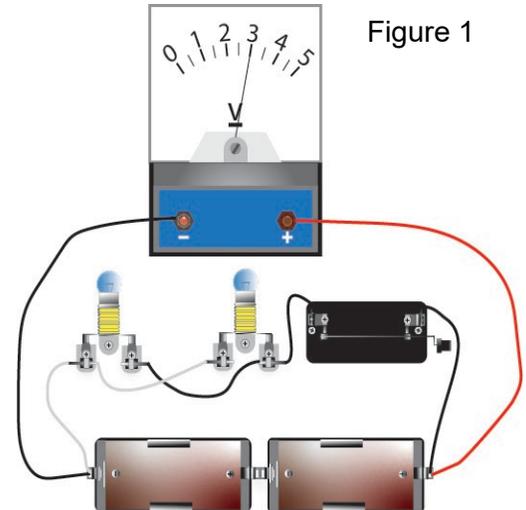
Voltage (V) is the energy force in wires or conductive materials in an electrical circuit. Voltage potential can be measured and is the difference between two points, for example between the positive and negative ends of a battery, or between a hot wire and neutral/ground wire. Voltage or Multi-meters are an inexpensive tool that are designed to measure voltage precisely. This project sheet will begin to help you explore how to measure for voltage and better understand potential difference.

### Keys to Remember

- Before attempting to use a voltage-meter, there must be an understanding of an electrical circuit and the ability to differentiate between an open and closed circuit.
- Working with live electrical circuits can be very hazardous without proper tools and safeguards. Ask an adult to assist you if you need extra guidance.
- The principles for taking measurements are the same regardless if the voltage is DC (Direct Current) battery or AC (Alternating Current) house wiring.
- Voltage and resistance readings will not be useful until also understanding voltage potential and loads/resistance in a circuit.

### Let's Get Started

A suitable place to start using and understanding a voltage-meter is on the first-year circuit board. First, find the voltage potential on the circuit board. In the future, this must be known for any electrical circuit before testing begins. The best place to read the initial voltage potential is at the batteries or the source of the power. With the meter set to DC voltage, touch the red test lead to the positive end of the batteries and the black test lead on the negative end, the voltage should read approximately 3 volts. This shows that the highest voltage potential reading taken anywhere on this circuit board is 3 volts (See Figure 1). (Note: When taking voltage measurements on an AC circuit, the color of the test lead does not matter)



Now, focus on the SPST (single pole single throw) switch. What voltage reading should you expect across the open switch? How about when the switch is closed? The open switch voltage should be 3, and the closed switch should read 0. When the switch is open, there is a voltage potential because the circuit is complete. The positive end of the battery connects to one side of the switch, and the negative end connects to the other side via the wire and the load/light bulbs. With the bulbs removed, one on a series circuit and two on a parallel circuit, the meter would read 0 volts. Now the path is open to the negative terminal. When the switch is closed, the meter will read 0 volts. The leads of the meter are

like birds' feet on a single wire. There is no voltage potential between them to measure (See Figure 2). On a working and completed light circuit in the home, one would see the same results across a SPST light switch. The internal workings of the switch or the routing of the wire cannot be seen.

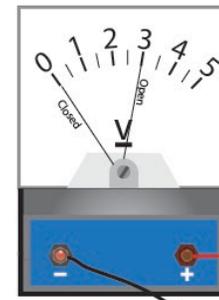


Figure 2

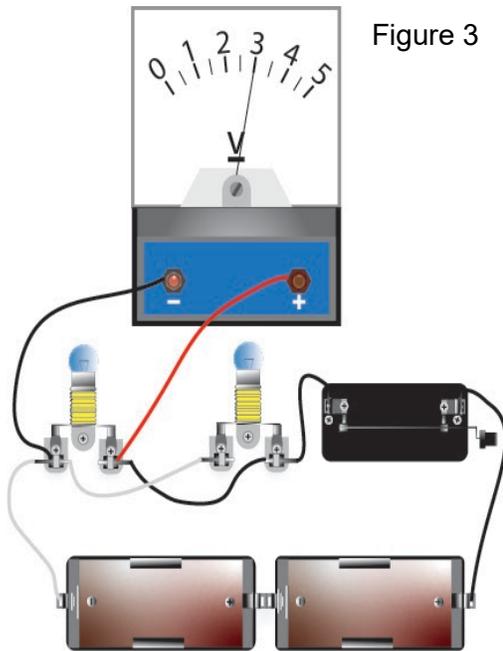
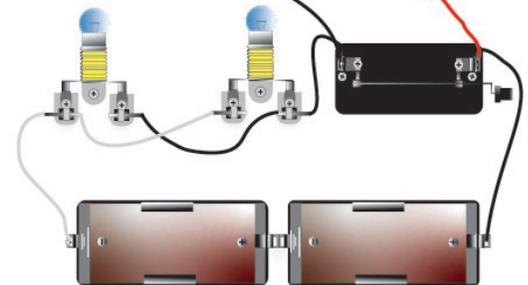


Figure 3

Take a few measurements across the loads/bulbs. Place the red test lead on the black wire from the switch and the black test lead on the white wire to the negative battery terminal. What should the voltage reading be? If the switch is open, the reading should be 0 volts due to the circuit not being complete to create the voltage potential. If the switch is closed, the voltage reading should be 3 due to the resistance of the load/bulb. The voltage

meter is still seeing full voltage potential (See Figure 3). If a series circuit were constructed and the voltage was measured across only one bulb, the meter would only read 1.5 volts because of the reduced potential by the resistance of the second load/bulb. The readings would be the same even if the circuit loads were different, such as a motor or transformer.

## Final Note

- Technicians approach most troubleshooting situations knowing how a circuit should function in a normal state.
- Voltage readings should not be a mystery once there is an understanding of a wiring circuit and the known voltage potential.
- Move cautiously while probing circuits.

## For the Project

- Research multi-meters
- Demonstrate use of voltage meter
- Include test data, diagrams, schematics, readings, and pictures
- Record sheet
- 4-H Exhibit Skills & Knowledge Sheet