

# Instructions for using a Multimeter

## WHAT IS A MULTIMETER?

A multimeter is a tool that combines the functions of an ammeter, voltmeter, and ohmmeter, which allows you to measure current, voltage, and resistance with one device. Because the multimeter can be used for various electrical measurements, it is essential that you plug the probe test leads into the proper terminal for the measurement (current, voltage, or resistance) you are recording.

This is a guide to help you properly use a multimeter to measure the voltage and current when using the Solar Technology Curriculum. Some of these activities use photovoltaic solar cells that produce a DC voltage to construct various circuits. While multimeters can measure both DC and AC voltage, AC voltage is not included in the scope of this guide.

## MEASURING VOLTAGE

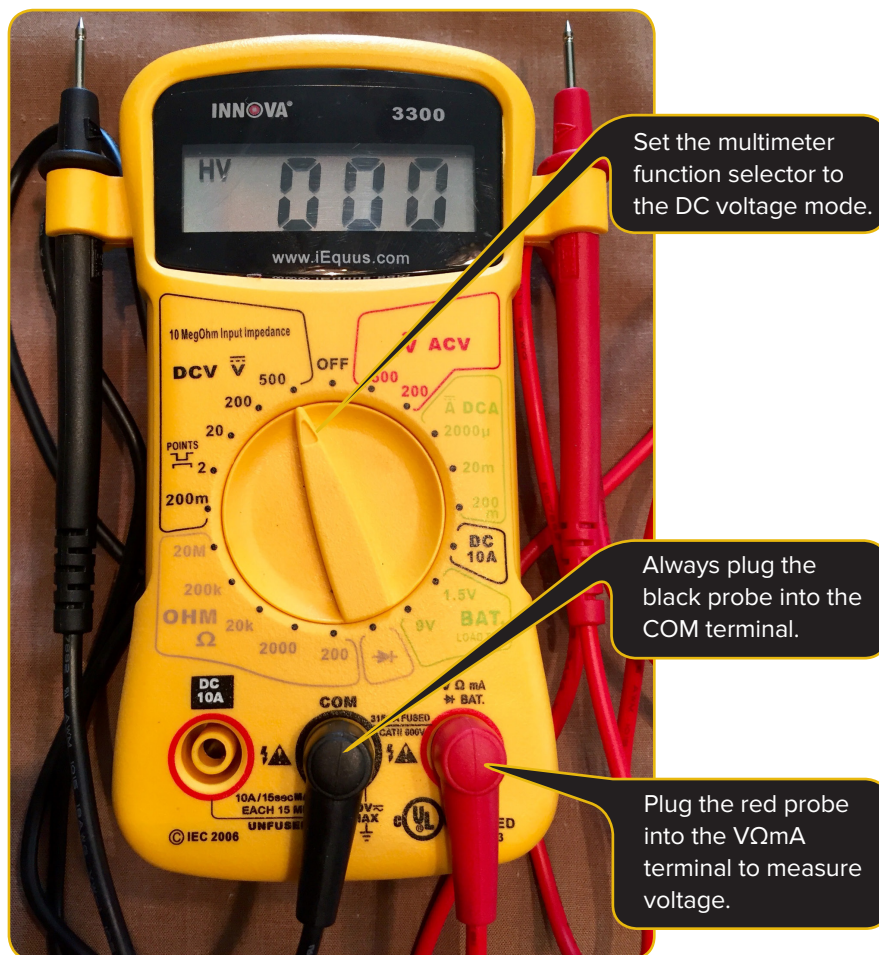
1. Plug the black probe into the common 'COM' terminal of the multimeter.
2. Plug the red probe into the VΩmA terminal.
3. Set the multimeter Function/Range selector to the appropriate DC voltage mode (indicated by a V with a solid bar over it, not a sine wave ~).

**Note:** Each setting on the dial lists the maximum voltage that can be measured in that range setting. If you are unsure what range to select, start with the highest range setting and work your way down to achieve the desired setting.

4. Place the red probe on the positive terminal, and the black probe on the negative terminal.

**Note:** If you reverse the probes you will still get an accurate voltage measurement, however it will give you a negative reading.

5. Record the results on the digital display screen.



**MEASURING CURRENT**

1. Plug the black probe into the common 'COM' terminal of the multimeter.
2. Plug the red probe into the DC10A terminal.
3. Set the multimeter Function/Range selector to the appropriate Amps range position.

**Note:** There are numerous types of multimeters with various ranges, however many have range settings allowing you to measure a current range from 0 to 200mA (milliamps) to 10A (Amps). To avoid blowing a fuse in the multimeter, start with the 10A jack until you are sure that the current is less than 200mA.

4. Disconnect the power source to the circuit.
5. To measure current, the multimeter must be included as part of the circuit. Place the red probe on wire that was disconnected and the black probe on the wire or location where the circuit was disconnected in the step above.

**Note:** If you reverse the probes you will still get an accurate current measurement, however it will give you a negative reading.

6. Reconnect the power source to the circuit.
7. Record the results on the digital display screen.

**SAFETY WARNINGS**

To avoid electrical shock and/or damage to the multimeter, always read the owner's manual including the safety and warning precautions, general use procedures, and service requirements.

Always consider electrical sources, circuits, and electronic equipment to be energized. Always keep your fingers behind the probe finger guards when taking measurements and do not use a multimeter or test leads that appear to be damaged.



# Solar Technology Curriculum Vocabulary

**Absorption** - The passing of a substance or force into the body of another substance.

**Active Solar Heater** - A solar water heater or space-heating system that uses pumps or fans to circulate the fluid (water or heat-transfer fluid like diluted antifreeze) from the solar collectors to a storage tank system.

**Ampere** - A unit of measure for an electrical current; the amount of current that flows in a circuit at an electromotive force of one Volt and at a resistance of one Ohm. Abbreviated as amp.

**British Thermal Unit (BTU)** - The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit; equal to 252 calories.

**Circuit(s)** - A conductor or a system of conductors through which electric current flows.

**Current (Electrical)** - The flow of electrical energy (electricity) in a conductor, measured in amperes.

**Conductor** - The material through which electricity is transmitted, such as an electrical wire, or transmission or distribution line.

**Convection** - The transfer of heat by means of air currents.

**Electrical Energy** - The energy associated with electric charges and their movements.

**Energy** - The ability to do work or the ability to move an object. Electrical energy is usually measured in kilowatt hours (kWh), while heat energy is usually measured in British Thermal Units (BTU).

**Heat Exchanger** - Any device that transfers heat from one fluid (liquid or gas) to another or to the environment.

**Heat Transfer Fluid** - A gas or liquid used to move heat energy from one place to another; a refrigerant.

**Induction** - The process of producing an electrical or magnetic effect through the influence of a nearby magnet, electric current, or electrically charged body.

**Insulation** - Materials that prevent or slow down the movement of heat.

**Insulator** - A device or material with a high resistance to electricity flow.

**Kinetic Energy** - Energy available as a result of motion that varies directly in proportion to an object's mass and the square of its velocity.

**Load** - The power and energy requirements of users on the electric power system in a certain area or the amount of power delivered to a certain point.

**Mechanical Energy** - The energy of motion used to perform work.

**Nonrenewable Fuels** - Fuels that cannot be easily made or "renewed", such as oil, natural gas, and coal.

**Ohm** - The unit of resistance to the flow of an electric current.

**Ohm's Law** - In a given electrical circuit, the amount of current in amperes (i) is equal to the pressure in volts (V) divided by the resistance, in ohms (R).

**Parabolic Trough** - A solar energy conversion device that uses a trough covered with a highly reflective surface to focus sunlight onto a linear absorber containing a working fluid.

**Parallel Connection** - A way of joining photovoltaic cells or modules by connecting positive leads together and negative leads together; such a configuration increases the current, but not the voltage.

**Passive Solar Heater** - A solar water or space-heating system in which solar energy is collected, and/or moved by natural convection without using pumps or fans.

**Photovoltaic Conversion** - The process by which radiant (light) energy is changed into electrical energy.

**Photovoltaic Cells** - A device, usually made from silicon, which converts some of the energy from light (radiant energy) into electrical energy. Another name for a solar cell.

**Potential Energy** - Energy available due to position.

**Power** - The rate at which energy is transferred. Electrical energy is usually measured in watts (Watts = Volts x Amps). Also used for a measurement of capacity.

**Radiant Energy** - Any form of energy radiating from a source in waves.

**Radiation** - Any high-speed transmission of energy in the form of particles or electromagnetic waves.

**Renewable Energy** - Energy derived from resources that are regenerative or for all practical purposes cannot be depleted. Types of renewable energy resources include moving water, (hydro, tidal and wave power), thermal gradients in ocean water, biomass, geothermal energy, solar energy, and wind energy.

**Resistance** - The inherent characteristic of a material to inhibit the transfer of energy. In electrical conductors, electrical resistance results in the generation of heat. Electrical resistance is measured in Ohms. The heat transfer resistance properties of insulation products are quantified as the R-value.

**Resistor** - An electrical device that resists electric current flow.

**Semiconductor** - Any material that has a limited capacity for conducting an electric current. Certain semiconductors, including silicon, gallium arsenide, copper indium diselenide, and cadmium telluride, are uniquely suited to the photovoltaic conversion process.

**Series Connection** - A way of joining photovoltaic cells by connecting positive leads to negative leads; such a configuration increases the voltage.

**Volt (V)** - The volt is the International System of Units (SI) measure of electric potential or electromotive force. A potential of one volt appears across a resistance of one ohm when a current of one ampere flows through that resistance.

**Voltage** - The difference in electrical potential between any two conductors or between a conductor and ground. It is a measure of the electric energy per electron that electrons can acquire and/or give up as they move between the two conductors.

**Watt** - A metric unit of power, usually used in electric measurements, which gives the rate at which work is done or energy used.

**All terms and definitions were retrieved from the following sources:**

U.S. Department of Energy. (2016, June). *Glossary of Energy-Related Terms*. Retrieved from Office of Energy Efficiency and Renewable Energy: <http://energy.gov/eere/energybasics/articles/glossary-energy-related-terms#C>

U.S. Department of Energy Energy Information Administration (USDOE/EIA). (2016, June). *Glossary*. Retrieved from Energy Kids U.S. Energy Information Administration: [http://www.eia.gov/kids/energy.cfm?page=kids\\_glossary#top-container](http://www.eia.gov/kids/energy.cfm?page=kids_glossary#top-container)