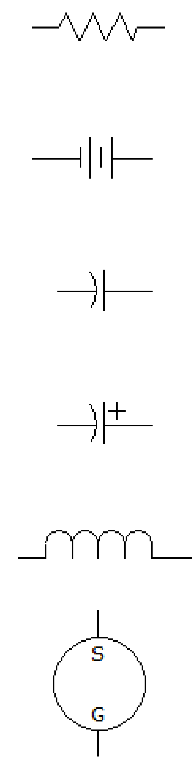
DC Resistor Circuits

- **Lab 2 deals with resistor circuits that have both DC and AC applied voltages.**
- **In solving electrical engineering problems, we usually have a circuit with applied voltages and we seek to discover the currents in the circuit (sometimes we have an applied current and we are solving for voltages, but not in this exercise).**
- **We will need to use three basic electrical engineering formulas today: Ohm's Law, and Kirchoff's Voltage and Current Laws.**

Circuit Symbols

- Resistor
- DC battery or voltage source
- Capacitor
- Polarized capacitor
- Inductor
- Signal generator

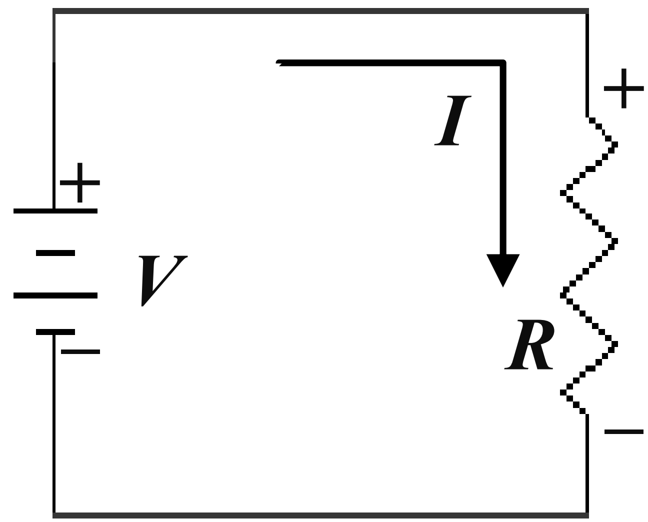


Notational Conventions

- **Three notational conventions in electrical engineering:**
  - **Current flows from the positive side of a DC source to the negative side. A relic of early circuit theory before we understood that electrons, not positive charges, move.**
  - **A voltage drop (e.g., as through a resistor due to current flow) is considered positive. This is simply a convention.**
  - **A voltage rise (as that through a battery from the negative side to the positive) is negative. Also simply a convention.**
  - **Node: A point at which two or more circuit elements are connected together.**
  - **Most generally, current entering a node is labeled negative; current leaving a node is labeled positive. Another convention.**

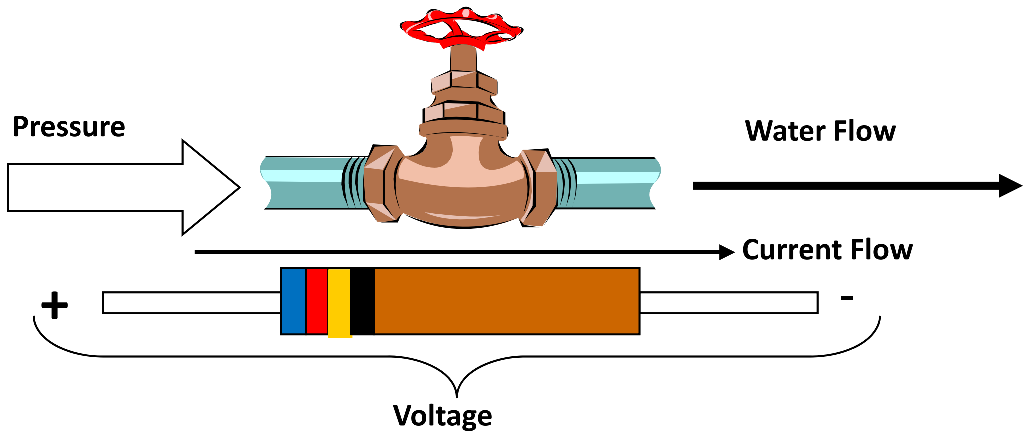
Ohm's Law

- Ohm's Law: The voltage across a resistor is equal to the current in the resistor times the resistance, voltage in Volts, current in Amperes, resistance in Ohms: $V=I \cdot R$



- Note: Amperes x Ohms = Volts

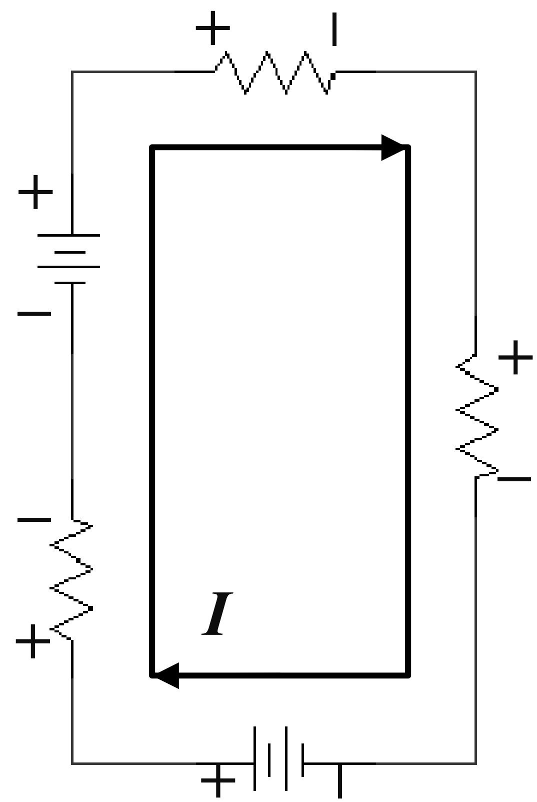
Analogy of Water Flow and Pressure



- **DC current flow is analogous to water flow in a pipe:**
  - **Pressure is similar voltage, forcing movement of water as voltage forces current flow in a conductor.**
  - **Pipe diameter is analogous to resistance; a smaller pipe diameter reduces water flow for a given pressure, just as a smaller conductance (larger resistance) reduces current flow.**

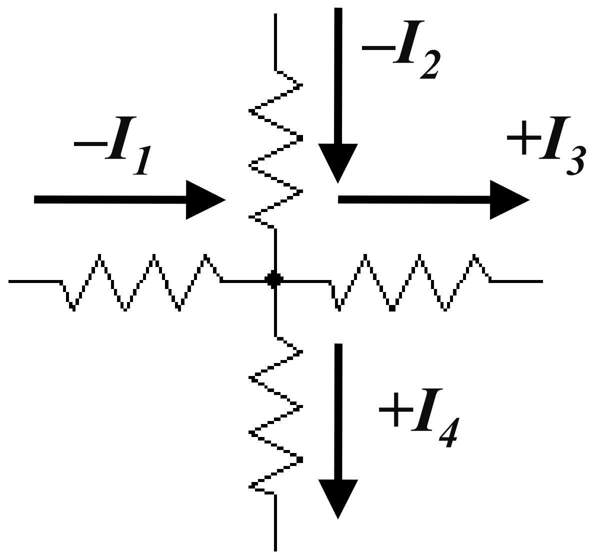
Kirchoff's Loop Voltage Law

- **KVL: The net voltage around a closed loop circuit is zero.**
- **Another way to state this is that the voltage rises (sources) in a closed loop equal the voltage drops (caused by resistors).**



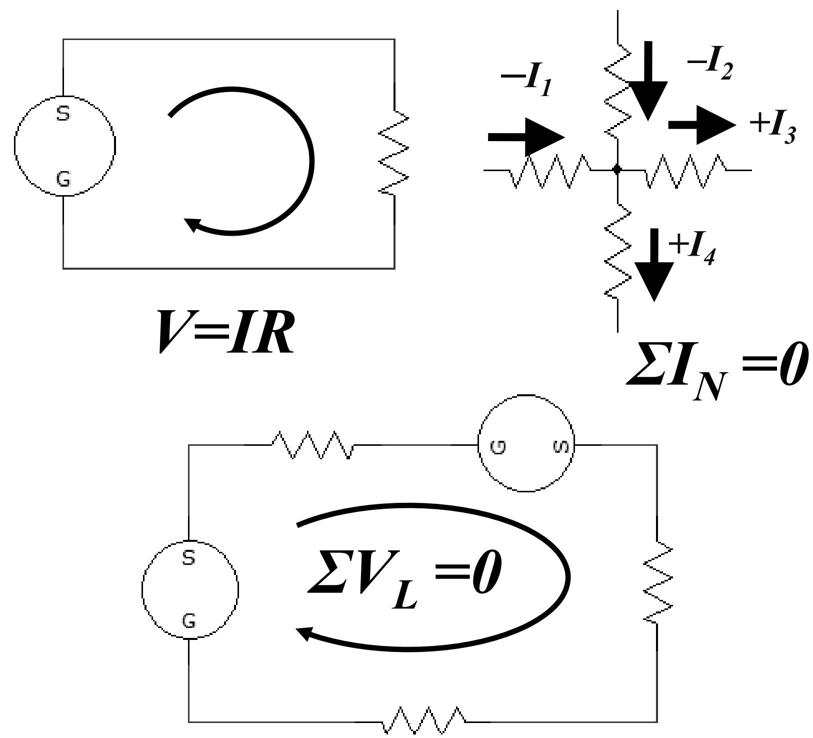
Kirchoff's Node Current Law

- **KCL: The algebraic sum of currents in any node is zero.**
- **Another way to say this is that the sum of currents entering the node is equal to the sum of currents leaving the node.**
- **Or:** $-I_1 - I_2 + I_3 + I_4 = 0$



AC Resistor Circuits

- Resistor circuits with an applied AC voltage obey the same three laws as DC circuits.
- Your AC circuits will be identical to the DC resistor circuits except for replacing the DC power source with an AC signal generator.



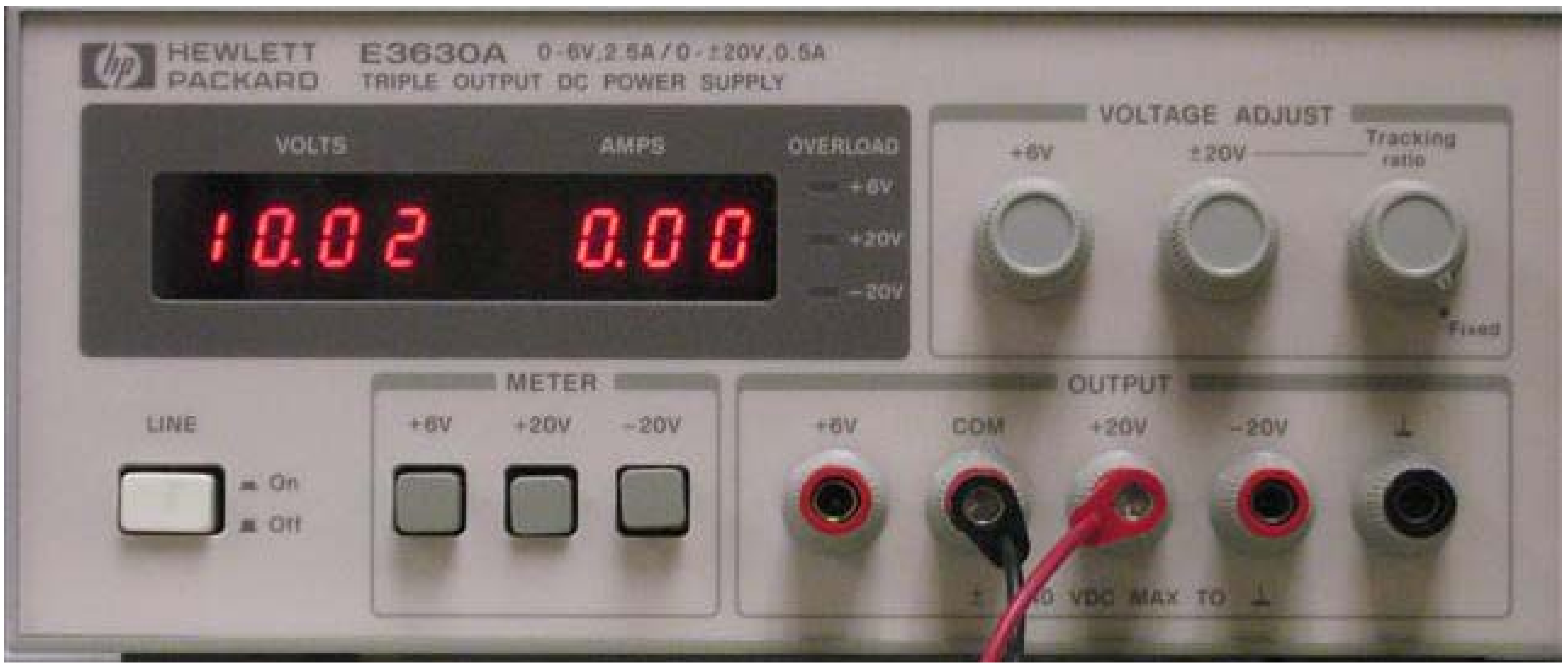
Measurement of AC Voltage

- **We will be applying a sinusoidal AC voltage to a resistor, that is a voltage of the form $v(t) = V_P \cos(\omega t)$, where V_P is the maximum AC amplitude.**
- **You will be able to see this sinusoidal waveform on the oscilloscope that you will use.**
- **You will also use a digital multimeter ("DMM") to measure the AC sinusoidal voltage. However, the DMM measures a constant value for this time-varying voltage. Question: What does the DMM measure?**

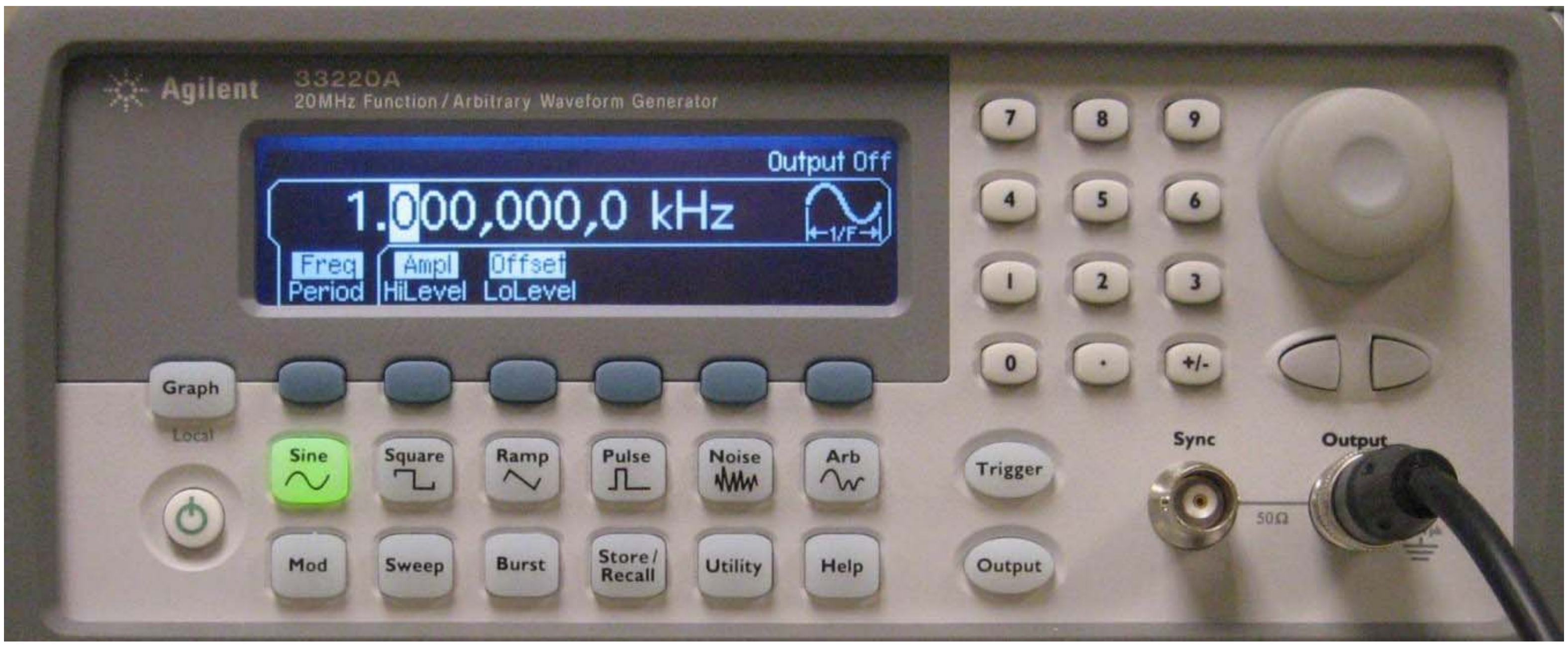
Measurement of AC Voltage (2)

- The DMM measures "effective" AC voltage, the "RMS" (root-mean-square) AC voltage, which is equivalent to a DC voltage in terms of delivering power to the circuit.
- For the sinusoidal voltage $v(t) = V_P \cos(\omega t)$ discussed above, the peak voltage is clearly V_P. The peak-to-peak voltage swing, which you will see on the oscilloscope, is V_{PP} (= 2 V_P). Skipping a calculus derivation, the RMS value of any sinusoidal voltage is $V_P / \sqrt{2}$, or $V_{PP} / (2\sqrt{2})$.
- We will use this definition of the RMS voltage in Experiment 5 as well.

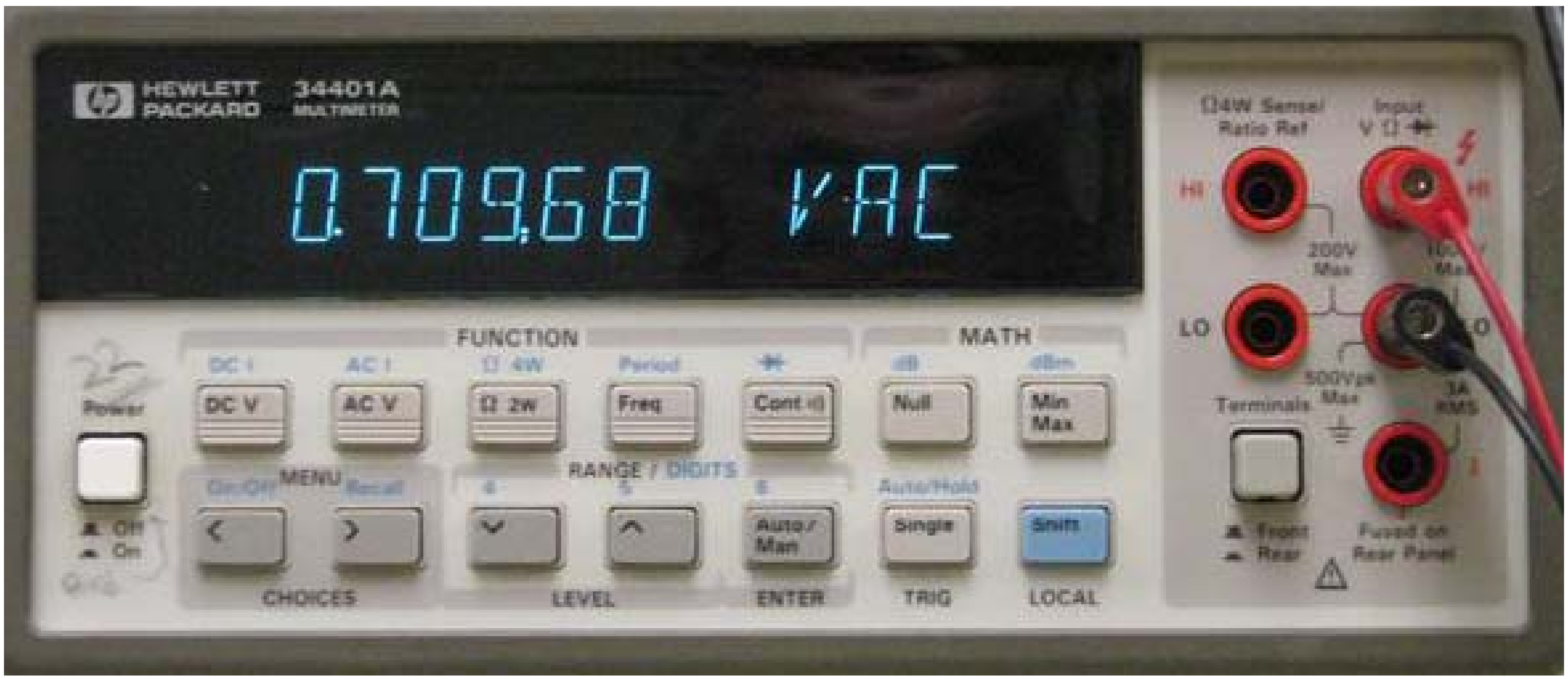
Instruments: DC Power Supply



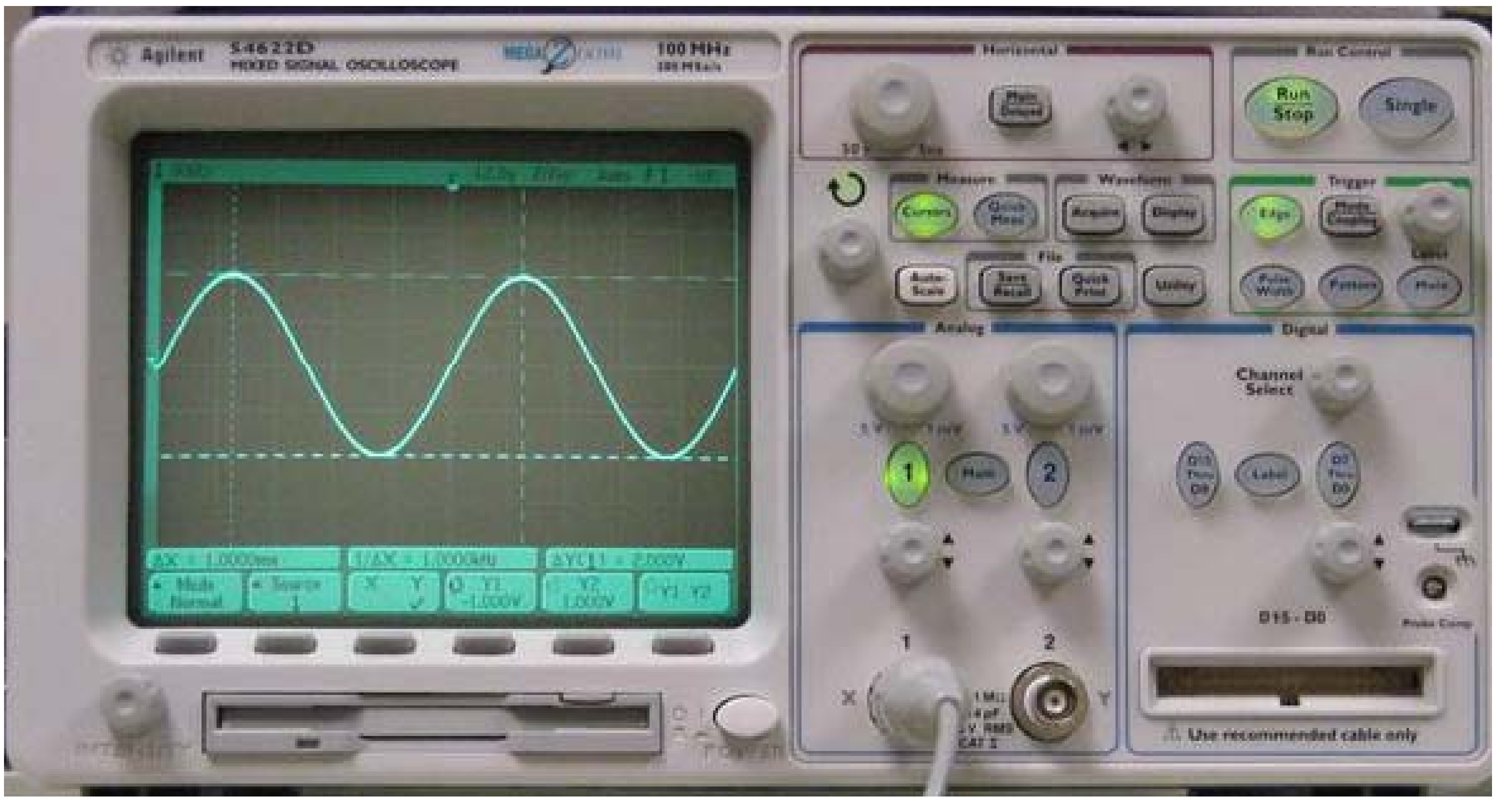
Signal Generator



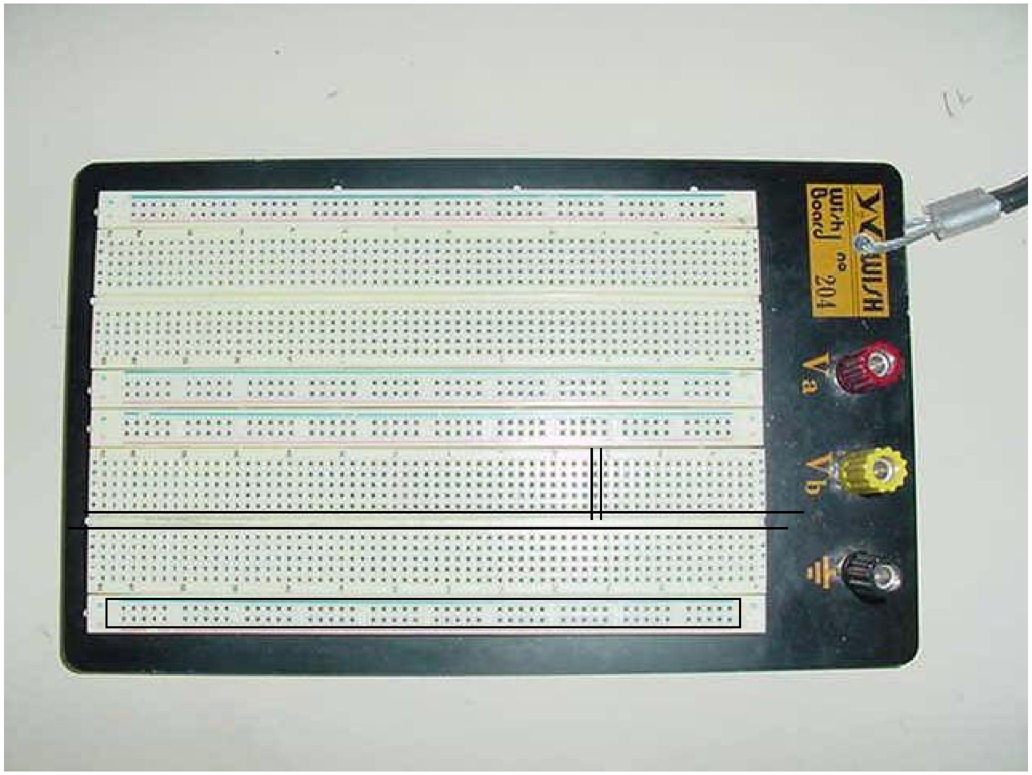
Digital Multimeter



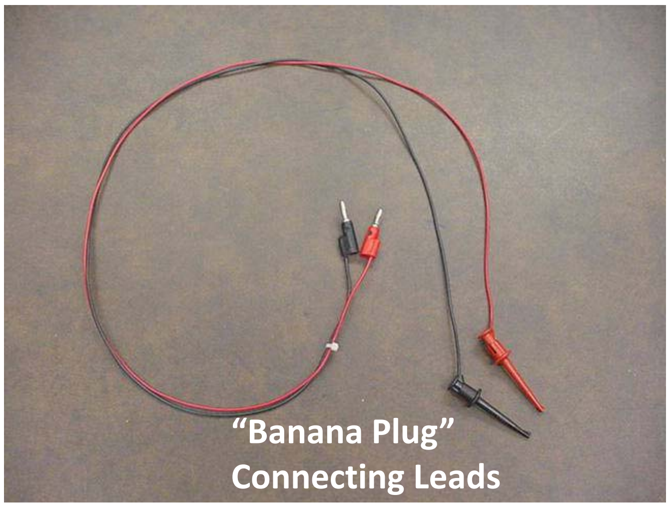
Oscilloscope



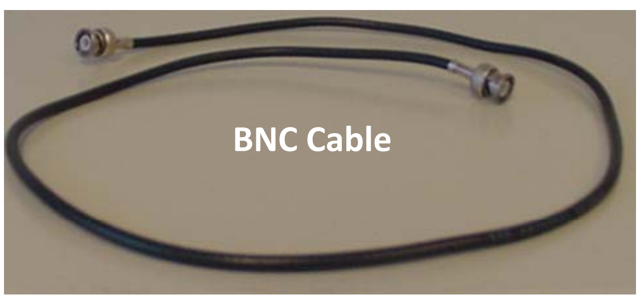
Circuit Prototyping Board

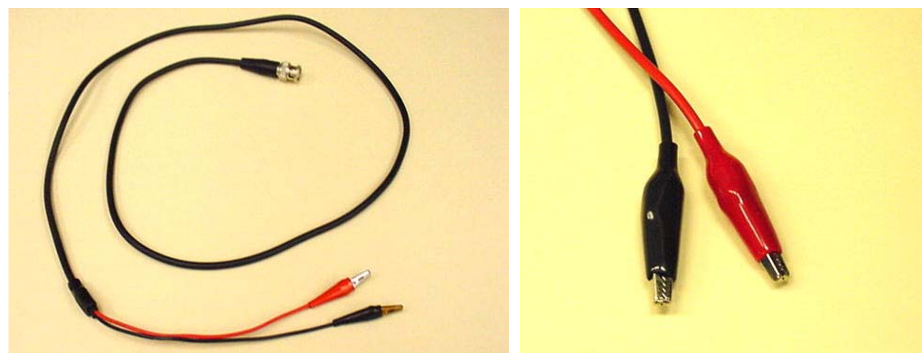


Connecting Leads


“Banana Plug” Connecting Leads


BNC-to-Hook End Connecting Leads


BNC Cable


BNC Cable with Alligator Clip Leads. Alligator clips may also be attached to banana plug cables.

Oscilloscope Probe