Kirchhoff's and Ohms Law

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Electrical Safety

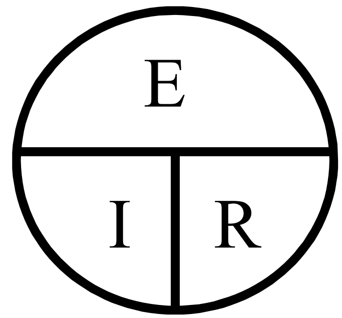
- Working on modern electronics is generally quite safe
- Exceptions
  - High powered amplifiers
    - 2,000 to 4,000 Volts
  - Tube type equipment
    - Receiver voltages are typically 350 Volts
    - Transmitter voltages are typically 750 Volts
  - Power lines
    - 2 Killed a couple of years ago
    - **Three People Killed While Erecting Antenna (ARRL News letter)**
      At approximately 8:40 PM on Monday, October 12, a man, woman and their 15 year old son were killed while trying to erect a 50 foot vertical antenna at the home of the man's mother, Barbara Tenn, KJ4KFF, in Palm Bay, Florida. The deceased were not licensed amateurs.
- Video

Kirchhoff's Law

- The sum of all the voltages around a loop equal to zero
  - You must go around the loop in one direction
  - The black lead is the reference voltage
  - The red lead is the measured voltage
  - The sum of the measured will equal zero
- Example: Skiing a loop
  - Height of the lift-sum of the drop of the trails back to the base=0
  - The altitude gained and lost in a complete loop is zero
  - Voltage (potential difference) is equivalent to change in elevation

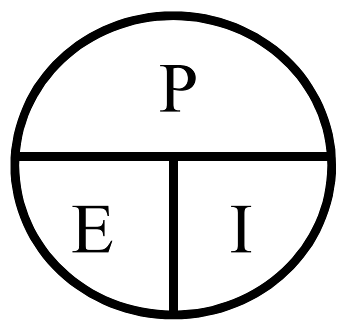
Ohm's Law

- Voltage =Current X Resistance



- Cover the unknown to get the formula

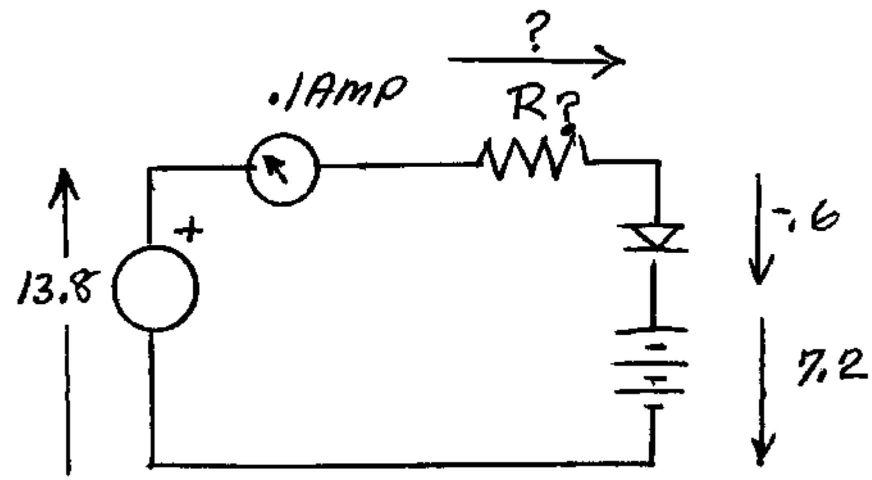
- Power=Volts X Current



Application

Charging a 7.2 volt NiMD battery pack

- Rated at 2,000 ma-hr
  - Charge at .1 X 2,000 =200ma
- Power supply is 13.8 Volts
- Kirchhoff's law
  - Power supply + resistor+diode+battery=0
  - 13.8 -V resistor -.6 -7.2 =0
  - Resistor voltage = 6 Volts
- Ohm's law
  - Resistance=6 volts / .200 Amps =30 Ohms
- Power on the resistor
  - Power =.2 amps X 6 Volts =1.2 Watts



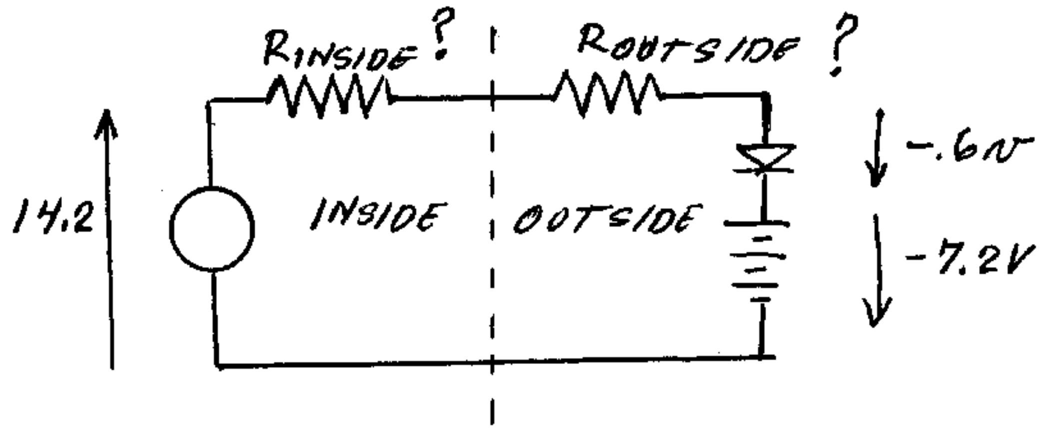
Options

- A 33 Ohm 1.5 Watt resistor
- 3 10 Ohm .5 Watt resistors in series
  - R total =R1 +R2+R3
- 3 100 Ohm .5 Watt resistors in parallel
  - 1/R total= 1/R1 +1/R2 +1/R3
  - On a calculator the key strokes are:
  - 100 (1/x) +100 (1/x) +100 (1/x) =1/x Your answer =33.3
- Test the circuit !

Assumptions

- Battery voltage is 7.2
- No resistance in the amp meter
  - An ideal amp meter has zero resistance
  - What happens if we forget to change the scale and try to measure voltage
  - Video
- No resistance in the power supply
  - Check the battery eliminator in the next example

Using a Battery Eliminator



- Specifications
  - Output 9 Volts
  - Current 200 ma
- Open circuit voltage
  - 14.2
- Voltage with a 100 Ohm load
  - 11.1
- Internal resistance
  - Current in the 100 Ohm resistor = 11.1 /100 = .111 Amps
  - Voltage drop internal = 14.2 - 11.1 =3.1 Volts
  - Resistance internal = 3.1 volts / .111 Amps = 27.9 Ohms
- Current into the battery with no resistor
  - Internal voltage drop =14.2 -7.8 = 6.4
  - Current = 6.4 Volts / 27.9 Ohms =.229 Amps or 229 ma

Volt Meters

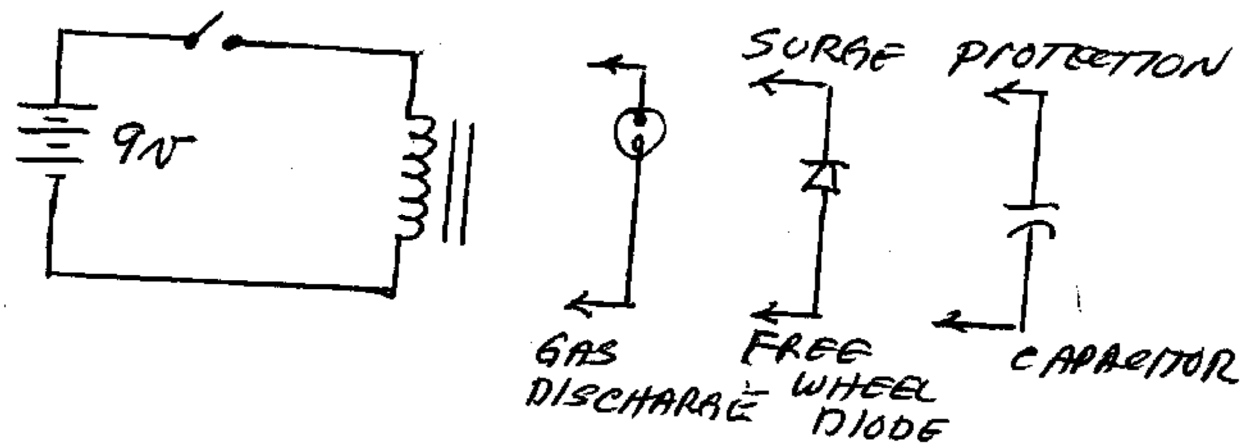
- Ideal volt meter
  - Infinite resistance
- Real volt meters
  - Draw power from a circuit
- Potential problems
  - Can lower the measured voltage due to current draw
  - Example
  - Many schematics will specify a Ohms per Volt meter
    - Resistance equals the Ohms per Volt times the meter scale
    - For example 10,000 Ohms per Volt and the 100 Volt scale =1,000,000 Ohms
  - Some meters have a fixed resistance like 10 M Ohms

Capacitive Discharge

- Capacitors can hold a charge a long time
  - Extremely high currents are possible
  - Potential hazard
- Vaporized copper!
  - Example
  - The copper can keep an arc going a long time
  - In high power circuits it can coat eyes and skin!
  - In low power circuits it can plate out on the cold surface of a fuse leaving you with no protection!

Inductive Kick

- Inductance stores energy in a magnetic field
- Inductance tries to keep the current flowing
- Interruption of the current can create very high voltages that can damage equipment
  - Example
  - Typical failures:
    - mobile radios when you start a car
    - switching transistors feeding a relay



Questions