Electronics

Merit Badge

TROOP 95

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Electronics Merit Badge Requirements

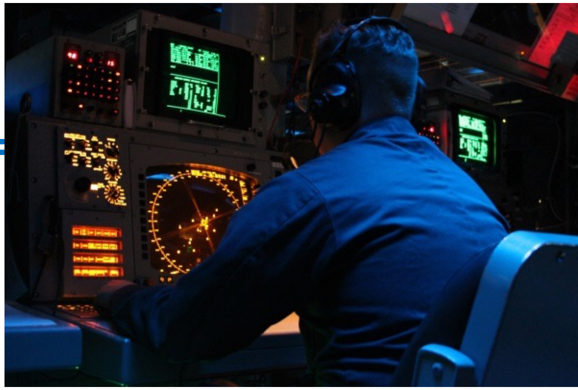
- **Be able to**
  - Show how to solve a simple problem involving current, voltage and resistance using Ohm's Law.
  - Use symbols and label electronic parts correctly (2a) and tell the purpose of each one.
  - Draw a simple schematic diagram of a circuit.
  - Name 3 types of test equipment, why we need them and how they operate.
  - Describe electronics for a control purpose. Build a control circuit.
  - Tell about audio circuits.
  - Tell about the basic principles of digital electronics.
  - Show how to change decimal numbers into binary numbers.

- **Build a project**
  - Describe the safety precautions to building and repairing electronics.
  - Show the right way to solder and de-solder (3a) and how to avoid heat damage to electronics.
  - Tell about the function of a printed circuit board and precautions to take when soldering them.
  - Show how to read the schematic for ***your project*** and explain how your circuit operates.
  - Build and demonstrate your project.

- Find out about careers in electronics. Learn about the training you will need.

Electronics

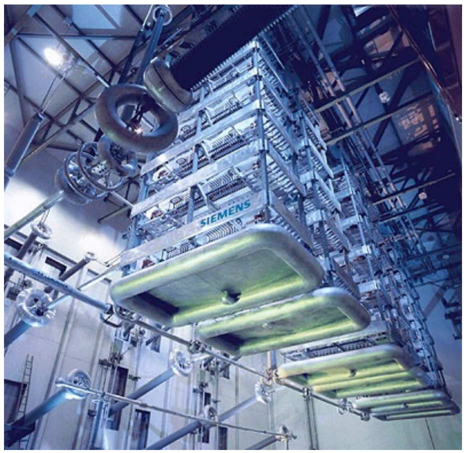
- We use electronics to change the form of electrical signals to do something useful.
- The first use of electronics was for “wireless” radio broadcasts.
- Electronic circuits change the SHAPE, AMPLITUDE (SIZE), FREQUENCY, or PHASE of signals.
- Electronics are used for the control of devices and machines.
- Electronic circuits can convert energy from one type to another such as providing the electrical energy to drive a speaker which converts electrical energy to sound that you can hear.
- Electronics are used to perform digital calculations (processors) and can store information (memory).



Radar and Air Traffic Control

Automotive

Satellites and Communications



Power

Radio

Smart Phones

Personal Computers

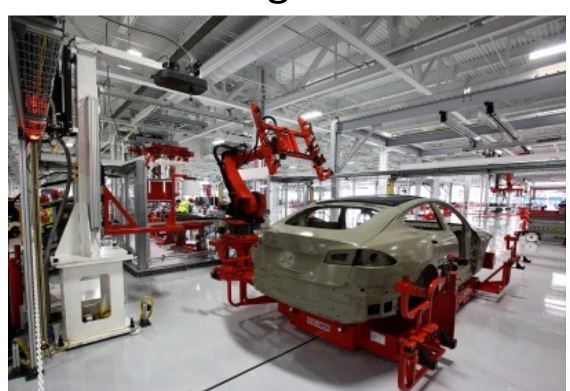
Navigation and Transportation

Television

Games

Medicine

Manufacturing and Robotics



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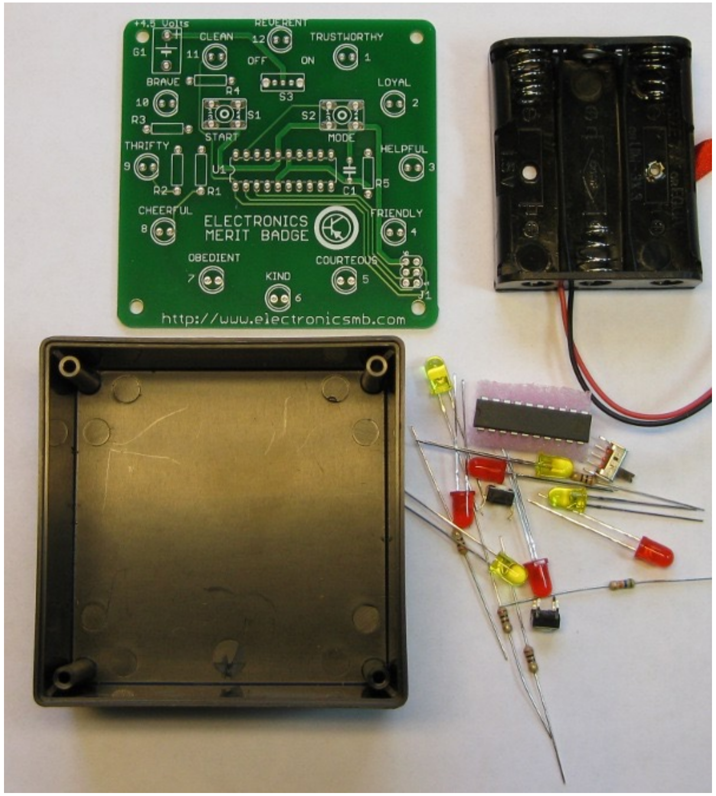
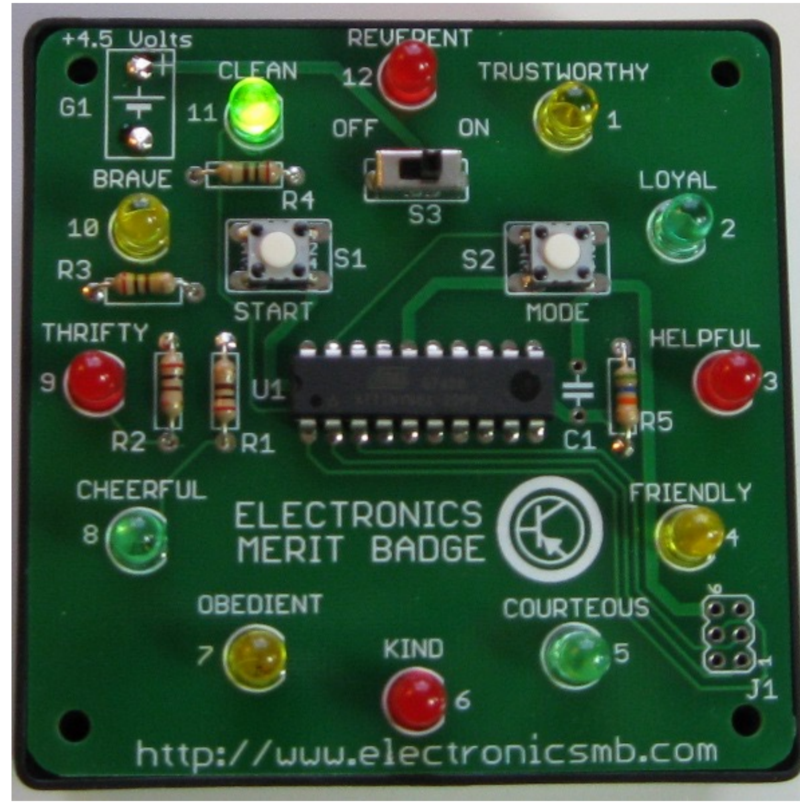
Electronics Merit Badge Project



Before

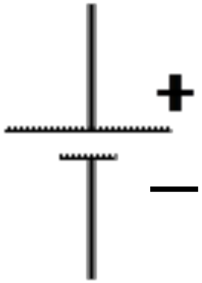


After

This is the project you will build.

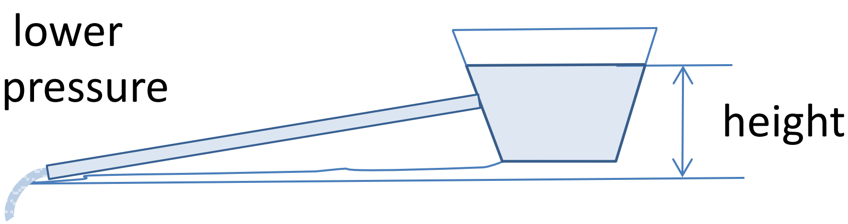
Voltage

- Voltage is the ***force*** that pushes electrons.
- Voltage is measured in: ***VOLTS***
- The abbreviation for Voltage is: **E**
- The schematic symbol for a battery
  (a source of DC voltage)



Voltage – Water Analogy

small height = low pressure = low voltage

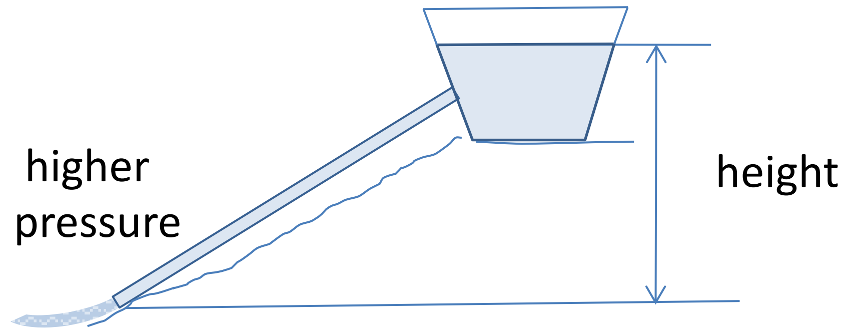


1. Gravity provides the force for water (current) to flow.

2. This illustrates a small voltage, so current flow is small.

3. You can increase water (current) flow by making the pipe larger.

big height = high pressure = high voltage



1. Gravity provides the force for water (current) to flow.

2. This illustrates a larger voltage, so current flow is larger.

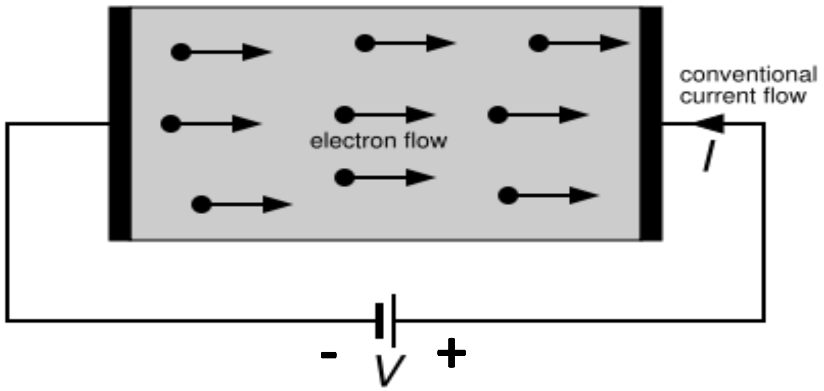
3. You can increase water (current) flow by making the pipe larger.

Current

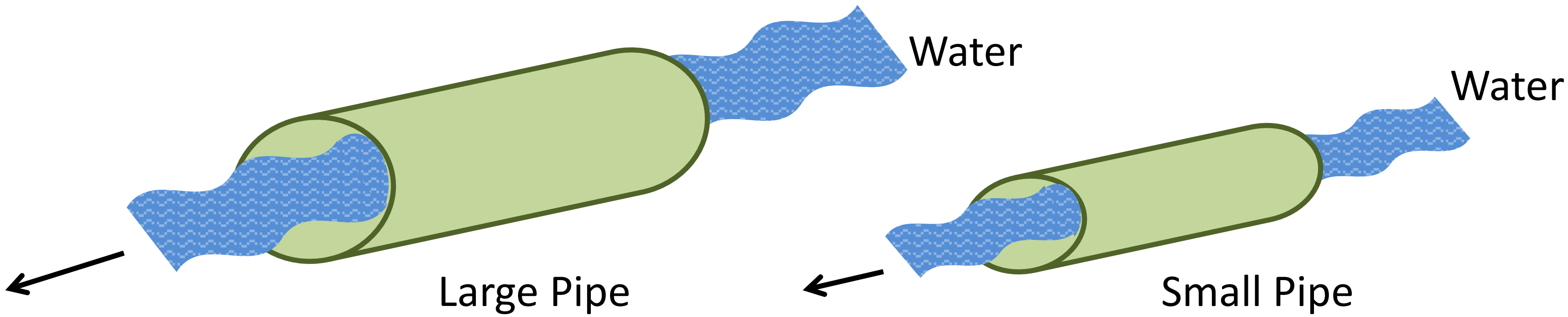
Current is the ***flow*** of electrons

Current is measured in: ***AMPERES*** or ***AMPS***

The abbreviation for Current is: **I**



Electrical Current Flow – Water Analogy



1. The water flow through a pipe is like electrical current or flow of electrons in a wire.
2. The volume of water flowing in a pipe is like the amount of electrical current flowing in a wire.
3. Large pipes allow more water to flow than a small pipe. Large wires can carry more electrical current than small wires.

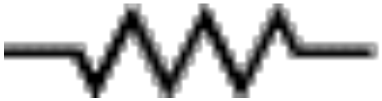
Resistance

- Resistance is the electrical property of a material that ***opposes the flow of electrons***

- Resistance is measured in: **OHMS**

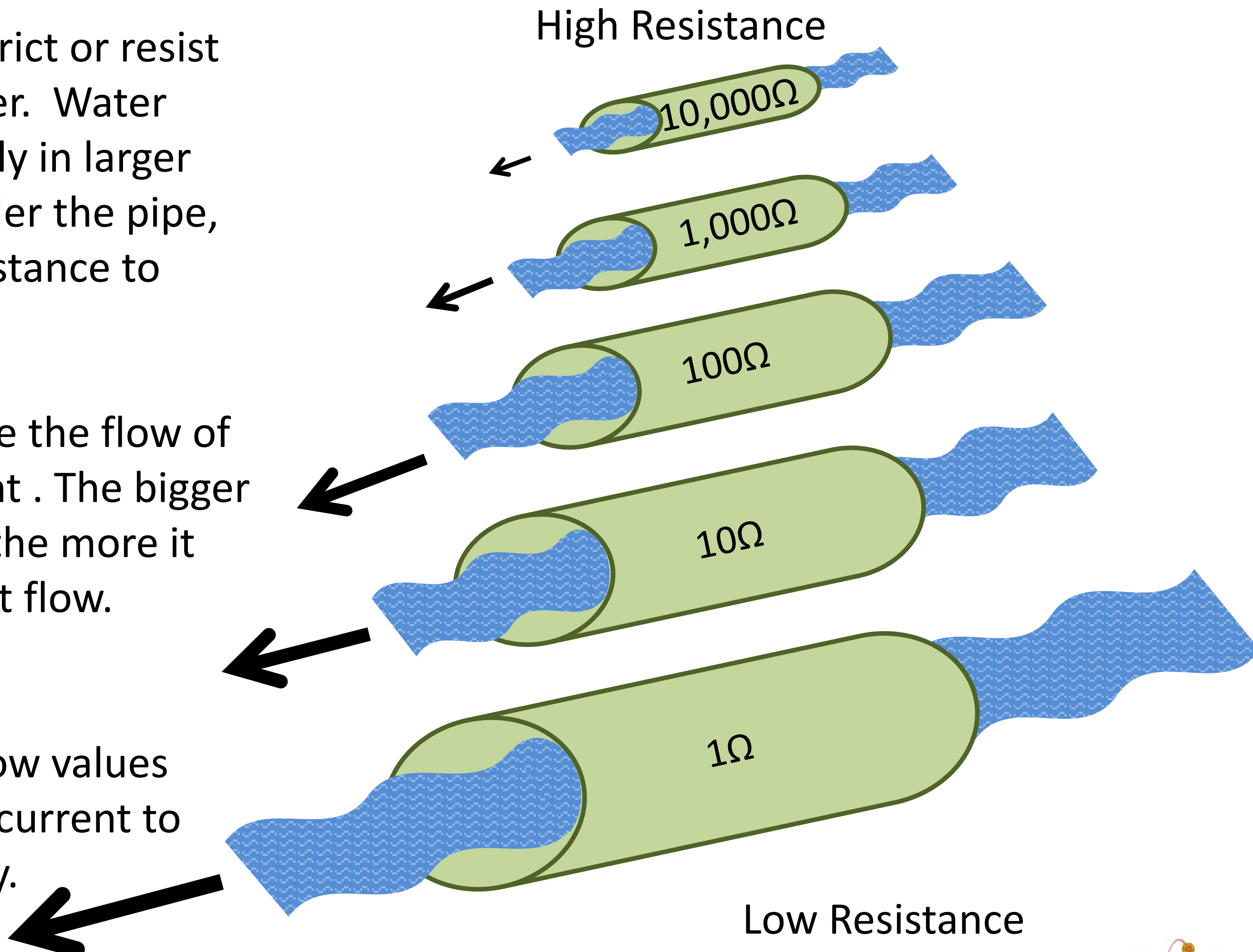
- The abbreviation for resistance is: **R**

- The electrical symbol for resistance is: **Ω**

- The schematic symbol for a ***resistor*** is: 

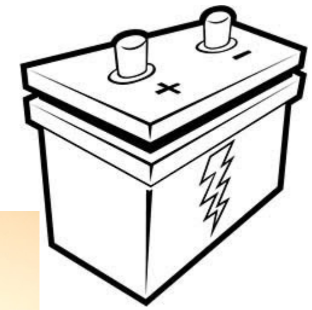
Resistance – Water Analogy

- Small pipes restrict or resist the flow of water. Water flows more easily in larger pipes. The smaller the pipe, the greater resistance to flow.
- Resistors oppose the flow of electrical current . The bigger the resistance, the more it opposed current flow.
- Resistors with low values allow electrical current to flow more easily.



Types of Electricity

Direct Current (DC)



Current only flows in one direction.

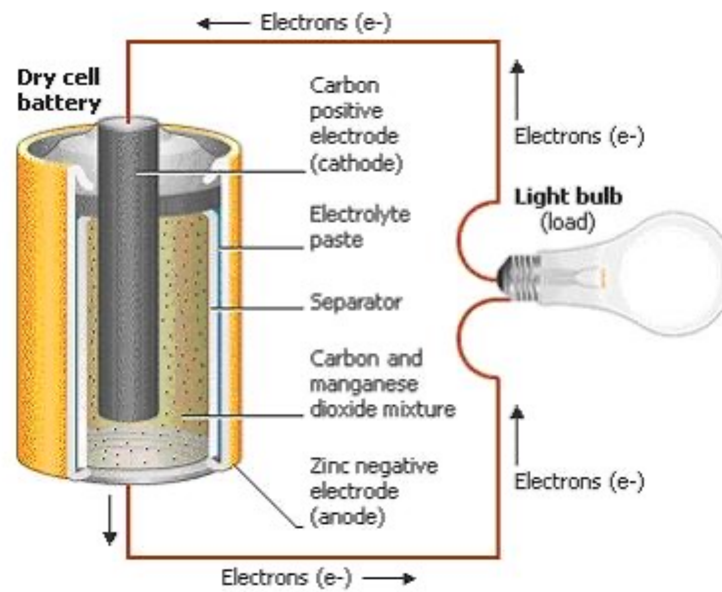
Type of electricity used in most electronics.

Most cars use a 12V DC battery.

Hybrid and Electric Cars have DC batteries.

Examples of things that use DC voltage:

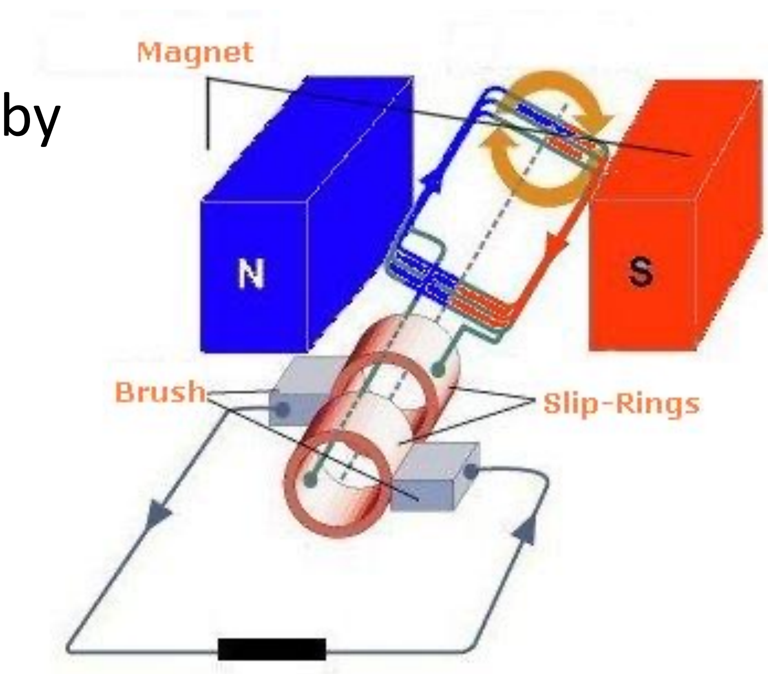
1. Cell phones
2. Laptop computers
3. Tablets
4. Remote Controls
5. Flashlights
6. Toys



Types of Electricity

Alternating Current (AC)

The common form of electricity generated by **Power Plants** for homes and industry.

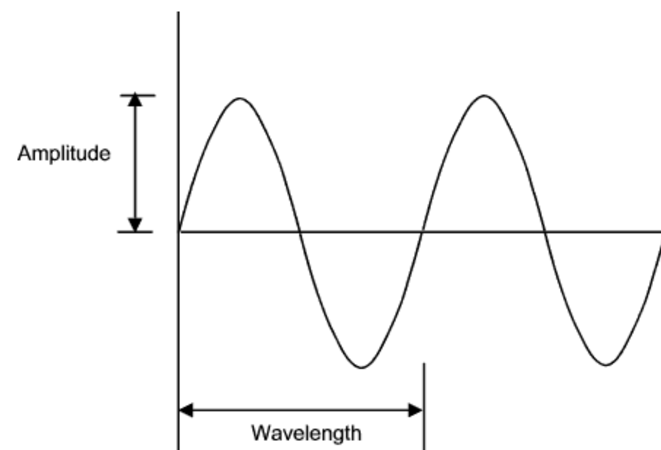


The direction of AC Current is reversed 60 times per second in the USA; 50 times per second in many other parts of the world.

Frequency is measured in ***Hertz***.

Examples of things that use AC Volts:

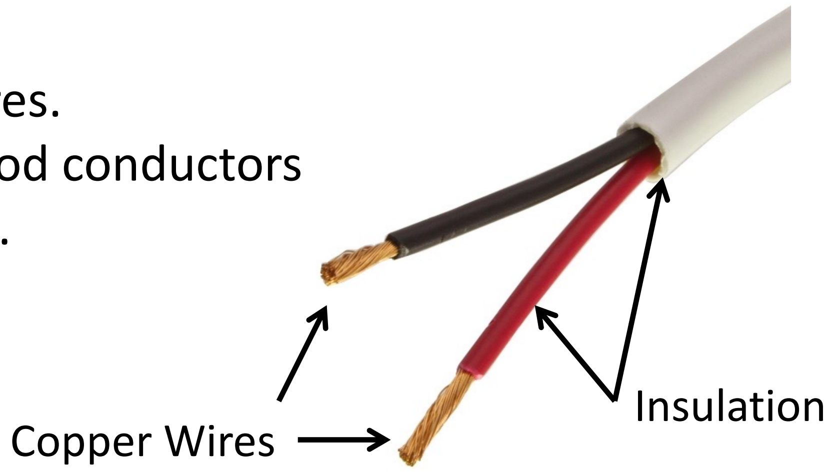
1. Lights
2. Stoves & Ovens
3. Washing Machines & Clothes Dryers
4. Refrigerators
5. Electric Fans
6. Air Conditioners



Conductors and Insulators

Conductors

- Act as a path for electrons to flow.
- Most metals are conductors.
- Metal is used for electrical cables and wires.
- Gold, silver, copper and aluminum are good conductors because they have a lot of free electrons.



Insulators

- Prevent the flow of electrons.
- Plastics, glass, and ceramics are good insulators because they don't have many free electrons.
- Insulators are used as the jacket on wires and cables to protect people from electrical shock and prevent 'short circuits'.

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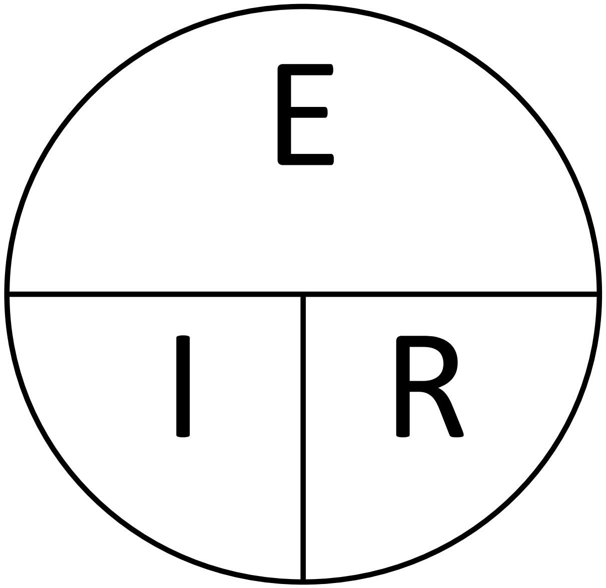
Ohms Law

Volts = Current x Resistance

$$E = I \times R$$



E Voltage Measured in Volts

I Current Measured in Amps

R Resistance Measured in Ohms

Example: *If the Resistance goes UP but the Voltage stays the same then the Current goes DOWN*

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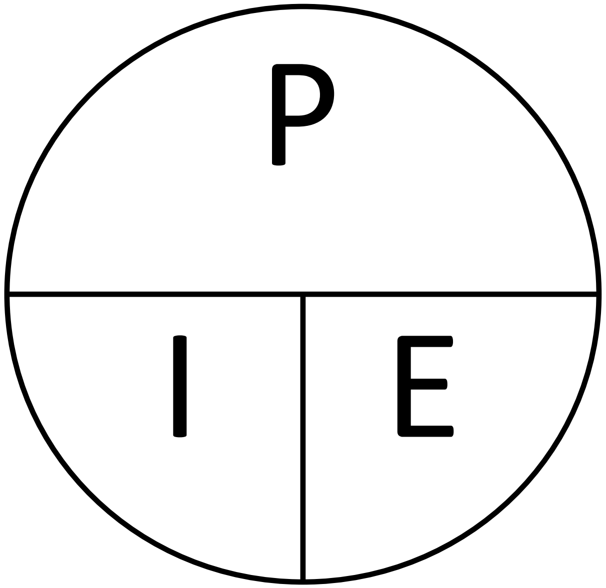
Ohms Law

Power = Current x Voltage

P = I x E



P Power Measured in Watts

I Current Measured in Amps

E Voltage Measured in Volts

Example: *If the Current goes UP but the Voltage remains the same, then the Power used by the circuit goes UP*

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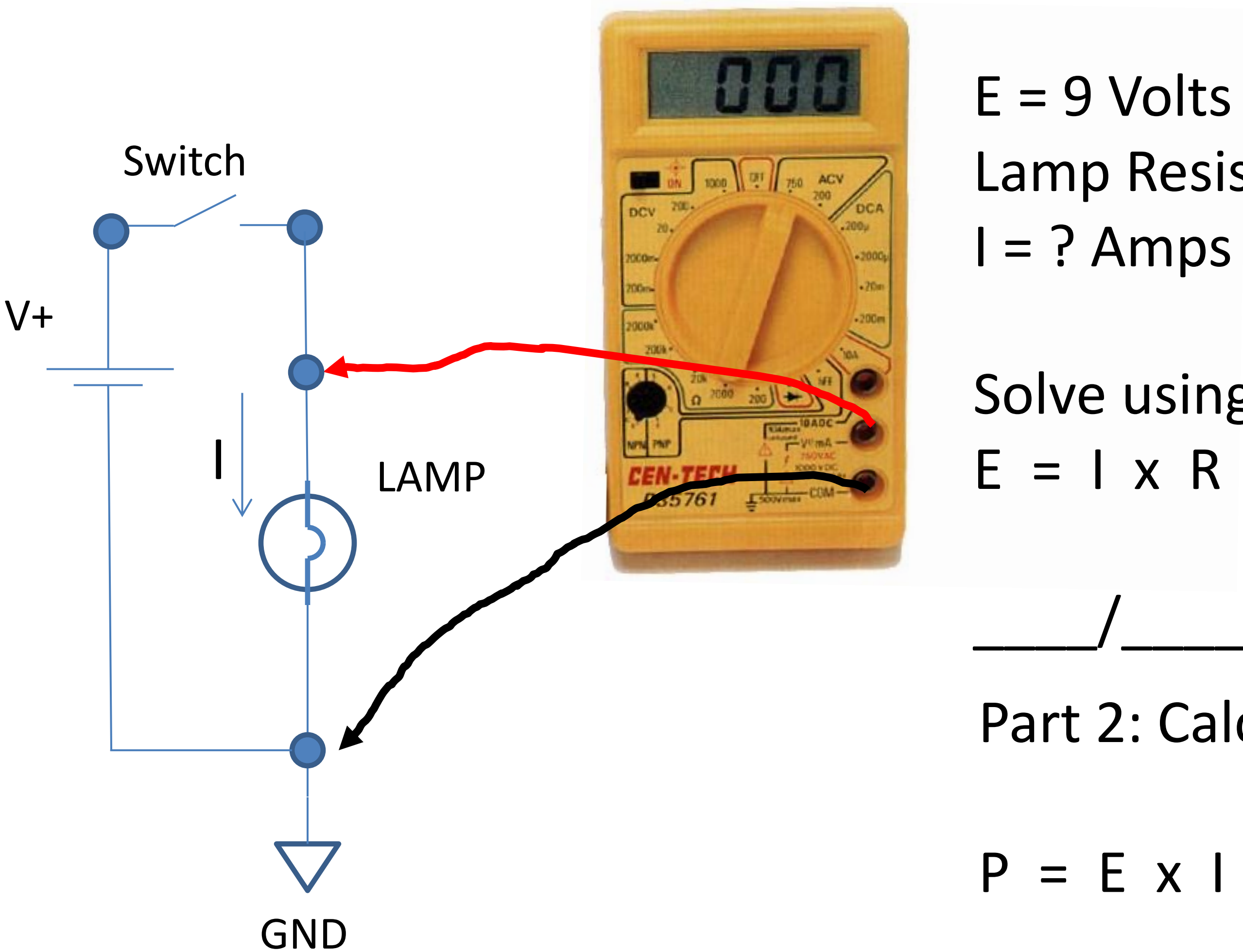
Ohm's Law

Worksheet



Part 1: Calculate the Current

E = 9 Volts

Lamp Resistance R = 3 Ohms

I = ? Amps

Solve using:

E = I x R so E / R = I

____/______ = _______ Amps

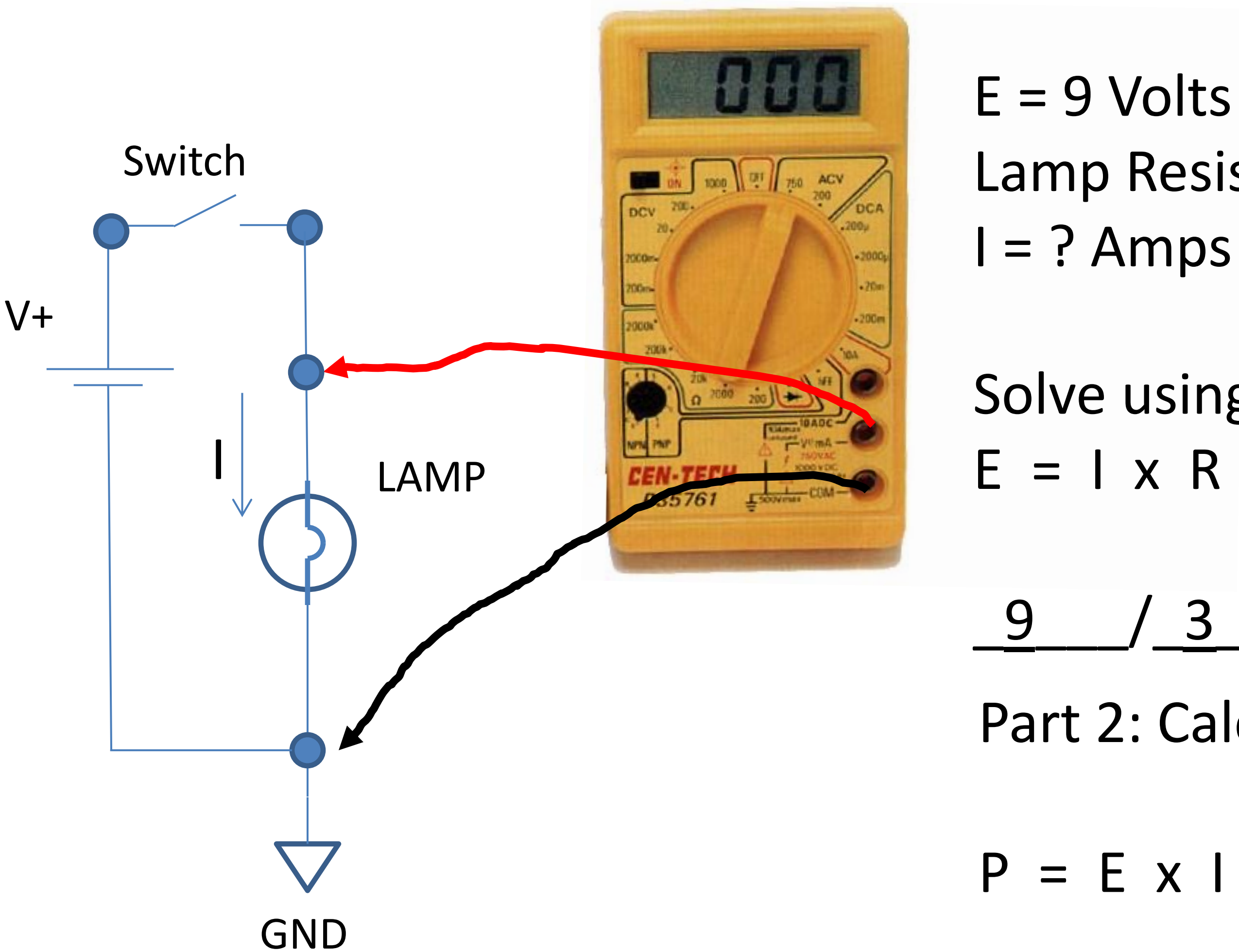
Part 2: Calculate Power (Watts)

P = E x I (from Part 1)

P = ____x ____= _____Watts

Ohm's Law

Worksheet Solution



Part 1: Calculate the Current

E = 9 Volts

Lamp Resistance R = 3 Ohms

I = ? Amps

Solve using:

E = I x R so E / R = I

_9___/_3____ = _3____ Amps

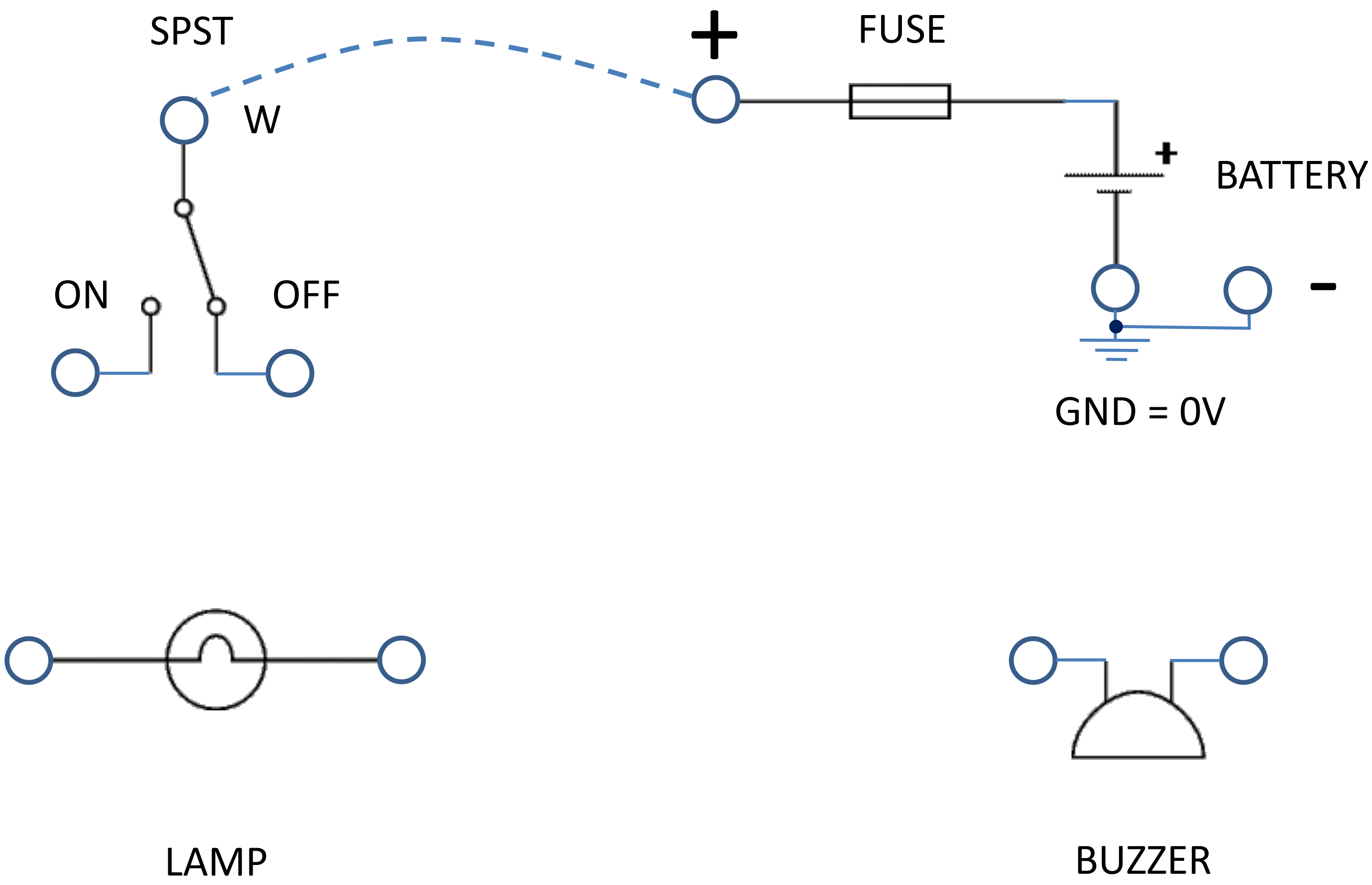
Part 2: Calculate Power (Watts)

P = E x I (from Part 1)

P = _9__x _3__= _27__Watts

CIRCUIT CONNECTION BOX

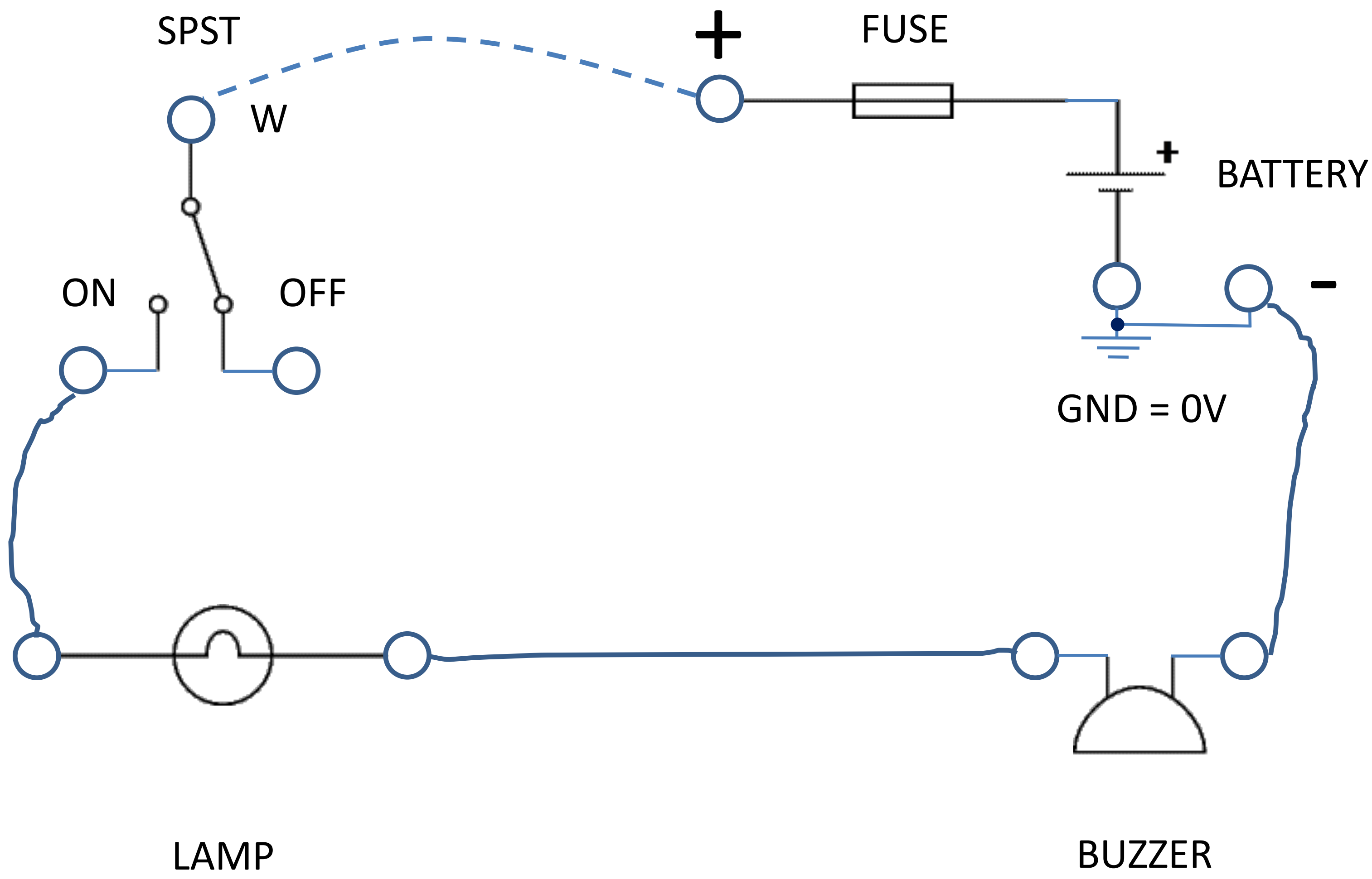
Draw a circuit to use the switch to turn ON and OFF the lamp AND the buzzer.



CIRCUIT CONNECTION BOX

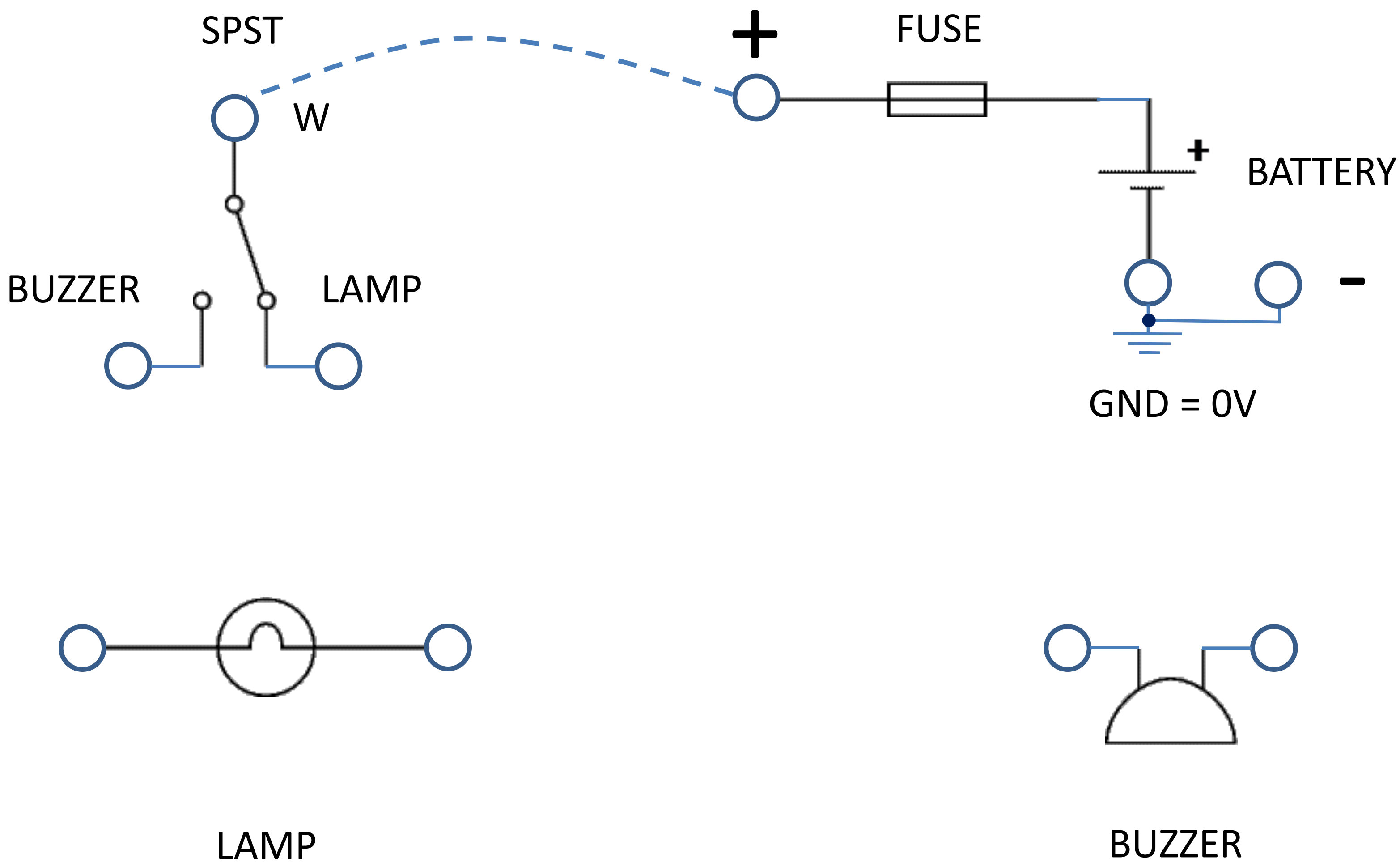
Draw a circuit to use the switch to turn ON and OFF BOTH the lamp AND the buzzer.

Solution



CIRCUIT CONNECTION BOX

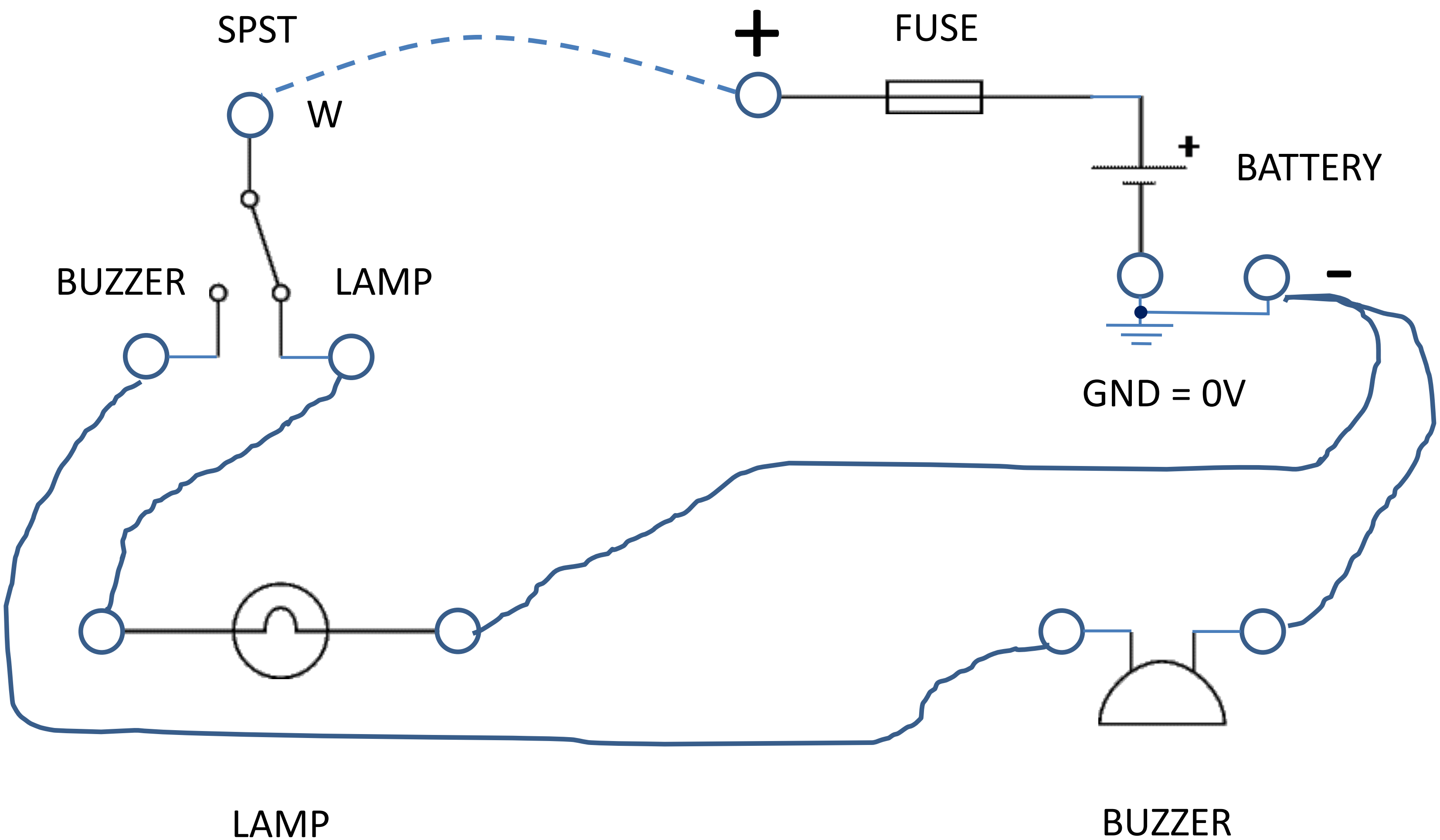
Draw a circuit to use the switch to turn ON the lamp OR the buzzer.



CIRCUIT CONNECTION BOX

Draw a circuit to use the switch to turn ON the lamp OR the buzzer.

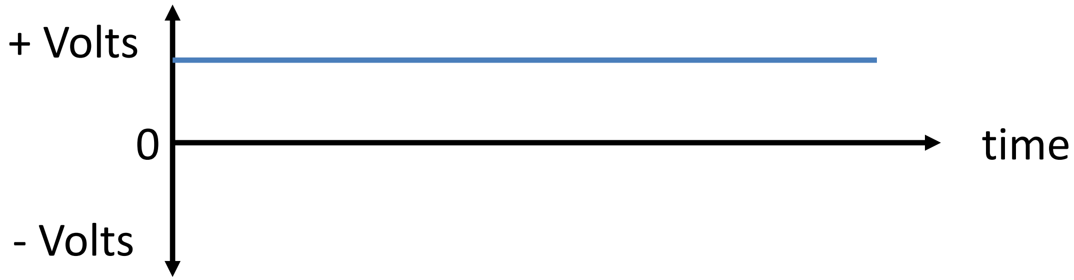
Solution



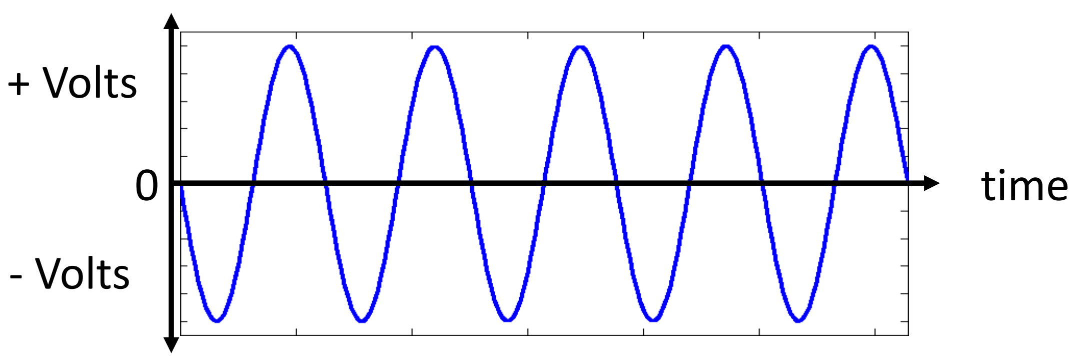
Review

Types of Electricity

Direct Current – DC   Electrical current flows in only ONE direction. DC power is supplied by batteries.



Alternating Current – AC Electrical current flows alternately in two directions - positive and then negative. The frequency is measured in **HERTZ**. **AC** power is supplied by the electrical outlets in your home.



Review

Voltage is the force that causes electrons (electrical current) to flow.
Measured in **VOLTS** the symbol is **E**

Current is the flow of electrons.
Measured in Amperes (**AMPS**) the symbol is **I**

Resistance is the property that opposes the flow of electrons.
Measured in **OHMS (Ω)** the symbol is **R**

Conductors act as a path for electrons to flow. Metals are conductors. Copper is used for electrical cables.

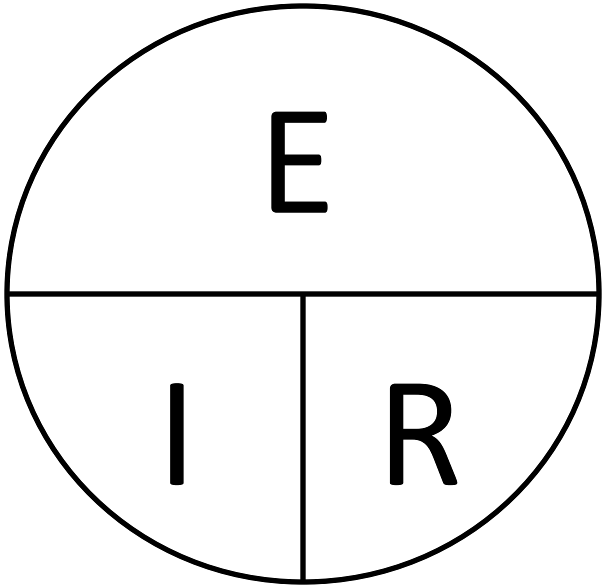
Insulators prevent the flow of electrons. Plastics, glass, ceramics, rubber are good insulators. Used for jackets on wires and cables to protect people and prevent 'short circuits'.

Review

Ohms Law

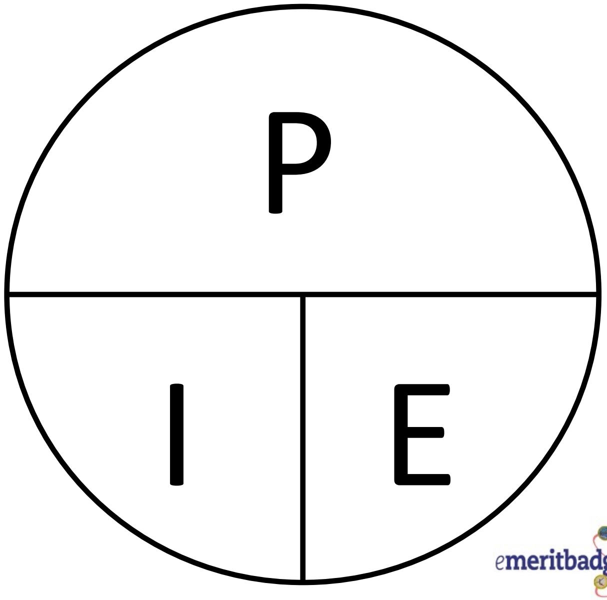
Voltage = Current x Resistance

E = I x R



Power = Current x Voltage

P = I x E



Power is measured in **WATTS**

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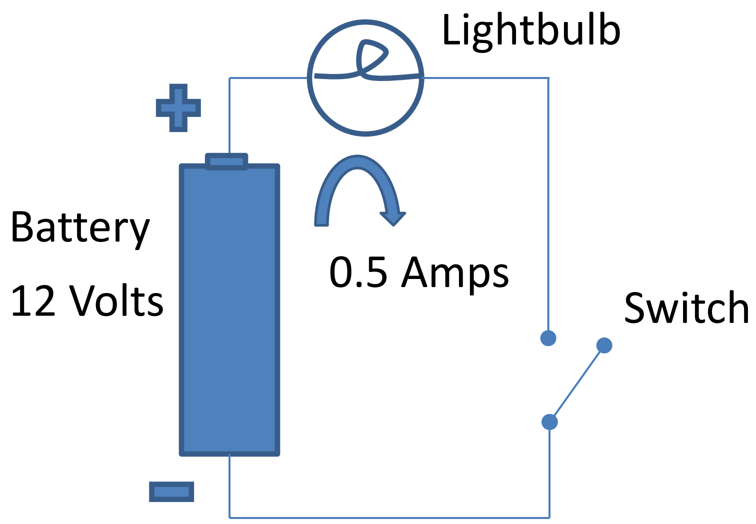
Review

Ohm's Law Worksheet Flashlight Example



I = 1/2 Amp = 0.5 A
V= 12 Volts

<u>Resistance of Light Bulb</u>

E = I x R

$$R = \frac{V}{I}$$

$$R = \frac{12\ V}{0.5\ A} = 24\ Ohms$$

<u>Wattage of Lightbulb</u>

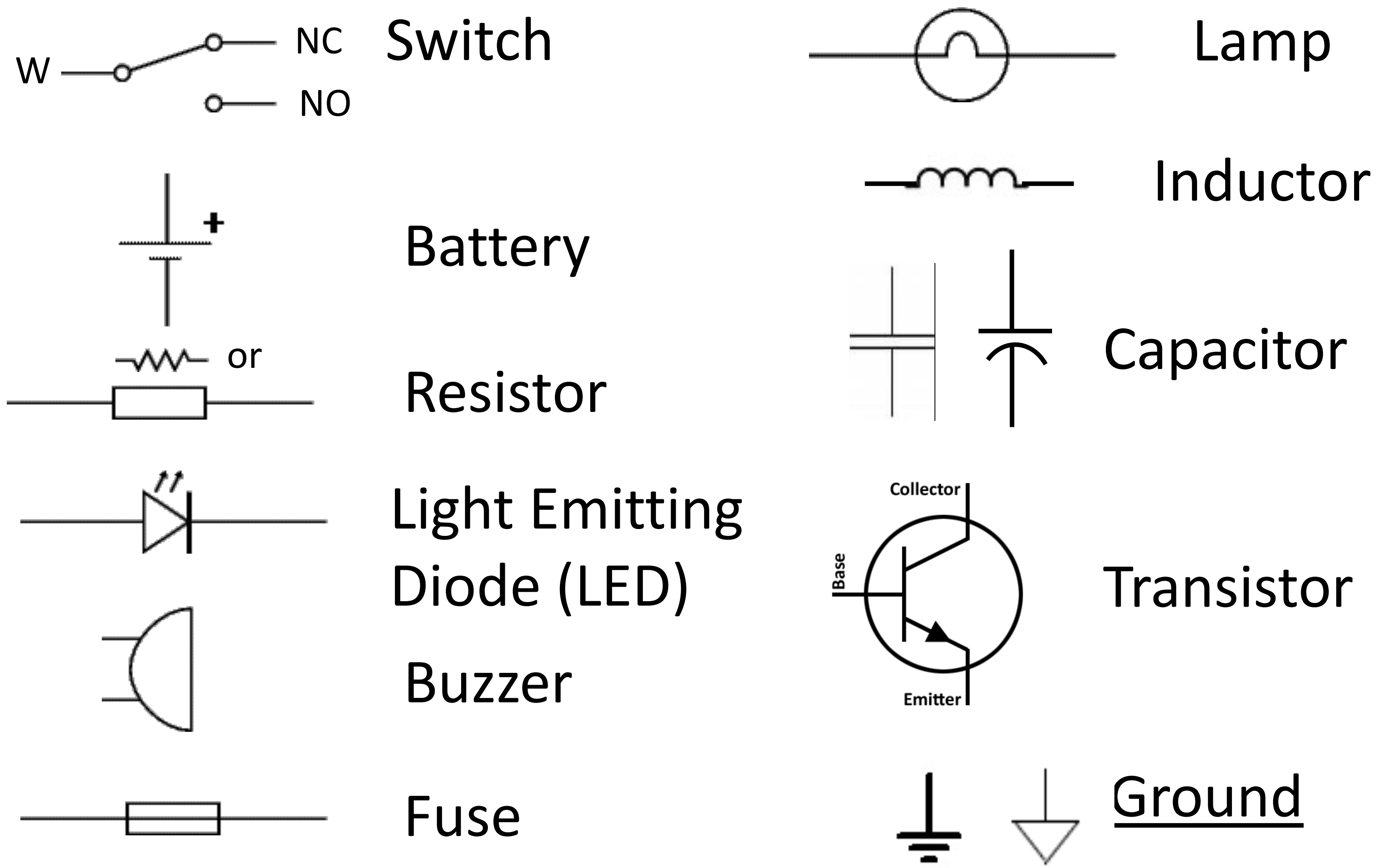
Power in Watts = Current x Voltage

P = I x E

P = 0.5 A x 12 V = 6 Watts

The lamp is a 6 Watt lightbulb.

Electronic Symbol Examples



Electronic Terms

Many electronic units are must be multiplied or divided by powers of 10 to be easily used. Examples are Kilobytes and Microfarads. These are the common multipliers used in electronics and their meanings:

Kilo – 1 Thousand 1,000 or 1x10+3
Mega – 1 Million 1,000,000 or 1x10+6
Giga - 1 Billion 1,000,000,000 or 1x10+9
Tera – 1 Trillion 1,000,000,000,000 or 1x10+12

Milli – One Thousandth 1 / 1,000 or 0.001 or 1x10-3
Micro - One Millionth 1 /1,000,000 or 0.000001 or 1x10-6
Nano - One Billionth or 1x10-9
Pico - One trillionth or 1x10-12

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Electronic Components

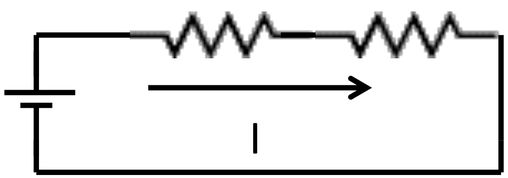
Resistor – The voltage across a resistor depends on the flow of current through it.

Resistance is measured in **OHMS**.

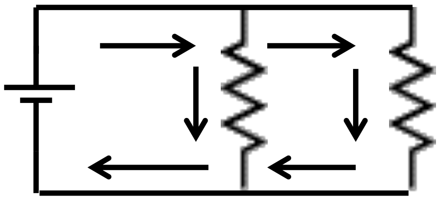
The abbreviation for resistance is: **R**

The electrical symbol for resistance is: **Ω**

The schematic symbol for a ***resistor*** is:



Resistors in Series Add Together



Resistors in Parallel Divide the Current

Resistor Color Code

0 = Black
1 = Brown
2 = Red
3 = Orange
4 = Yellow
5 = Green
6 = Blue
7 = Violet
8 = Gray
9 = White

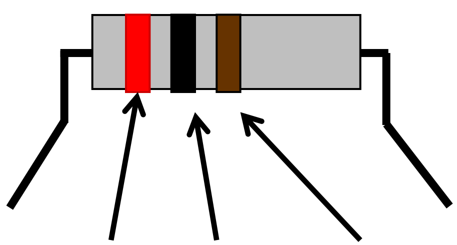
1st color band = 1st digit
2nd color band = 2nd digit
3rd color band = 10x multiplier (number of zeroes)
4th color band = tolerance (accuracy)

<u>Example 1:</u>

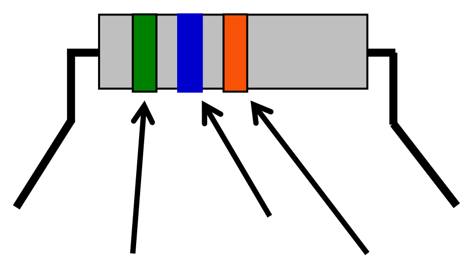
1st = Red = 2
2nd = Black = 0
3rd = Brown = x 10
20 x 10 = 200 Ω

<u>Example 2:</u>

1st = Green = 5
2nd = Blue = 6
3rd = Orange = 3 = x 1000
56 x 1,000 = 56,000 Ω = 56K Ω



200Ω, Red, Black, Brown



56KΩ Green, Blue, Orange

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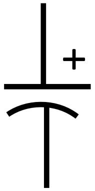
Electronic Components

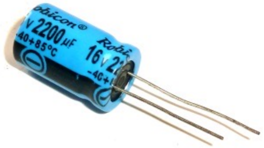
Capacitor – Used to store an electrical charge. The electrical size of a capacitor is Charge divided by Volts. Capacitors are used to filter electrical signals and tune radio circuits to desired frequency.

Capacitance is measured in **FARADS**

The abbreviation for capacitance is: **F**

The schematic symbol for a capacitor is:





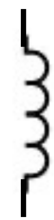
Electronic Components

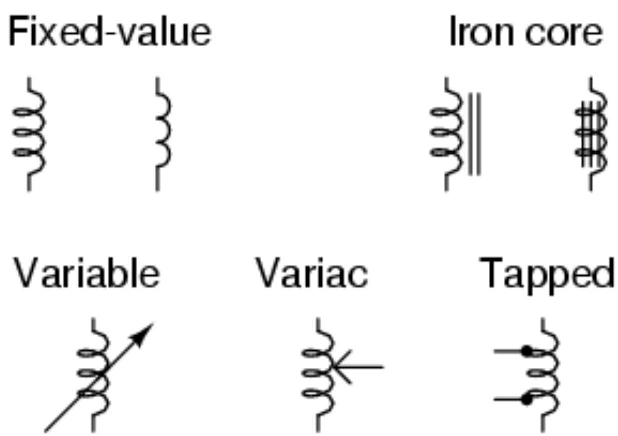
Inductor (Coil) – The voltage across an inductor is proportional to how quickly the current flow is changing. Inductors are used to tune a radio circuit to a desired frequency or can filter electrical signals.

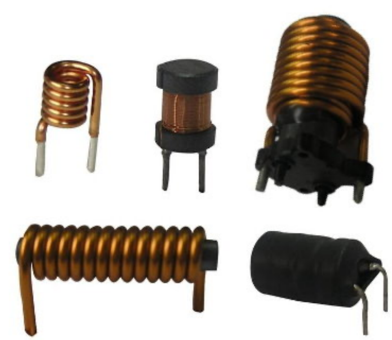
Inductance is measured in: **HENRIES**

The abbreviation for inductance is: **L**

The schematic symbol for an inductor is:





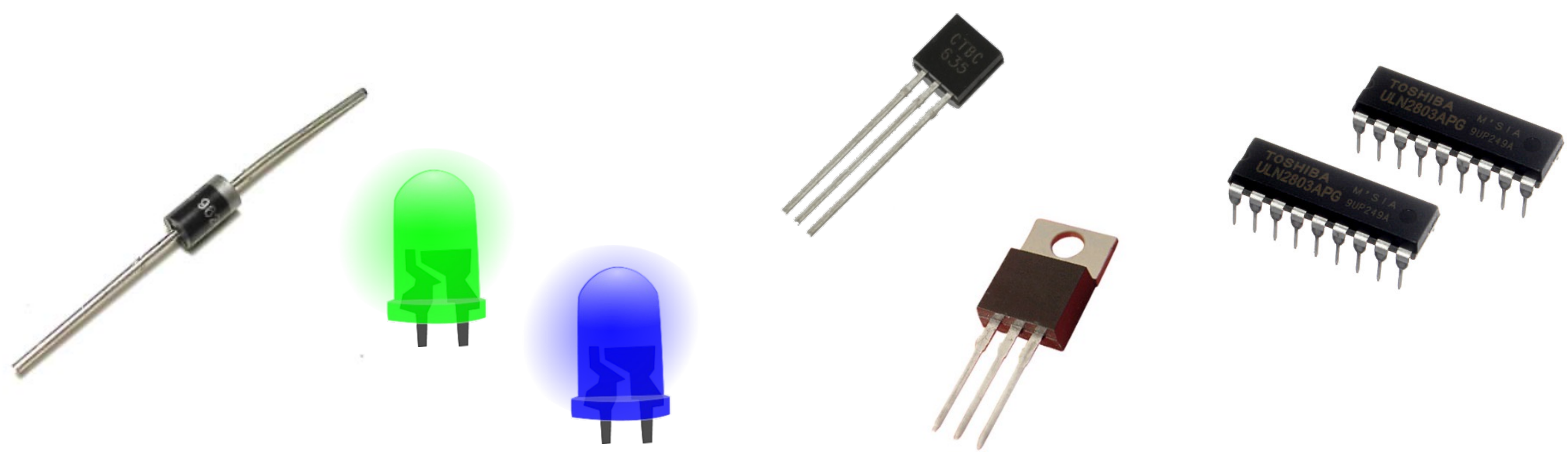


Semiconductors

Semiconductors are able to conduct the flow of electrons more easily than insulators but not as easily as metals and only under certain conditions.

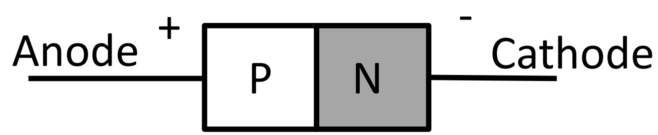
The most common semiconductors are made of **Silicon** and **Germanium**.

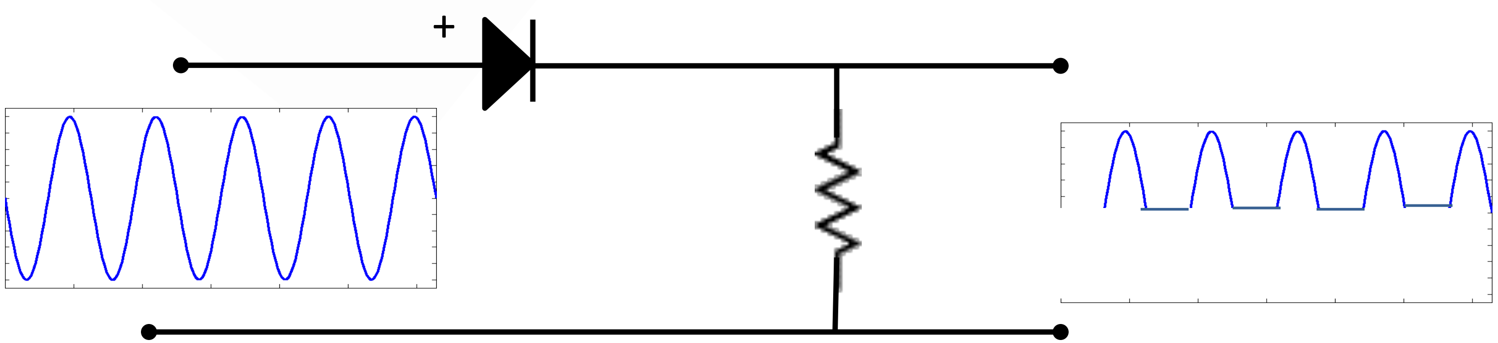
Diodes, **Transistors** and **Integrated Circuits** are all semiconductors.



Diodes

- **Diodes** are semiconductors that are able to conduct the flow of electrons in one direction and block current flow in the opposite direction.
- Diodes are like a “one-way” valve for electron current flow. Diodes consist of two processed materials called P-type and N-type semiconductors. They are in direct contact, forming a region called the P-N junction.
- The most common diodes are made of Silicon or Germanium.



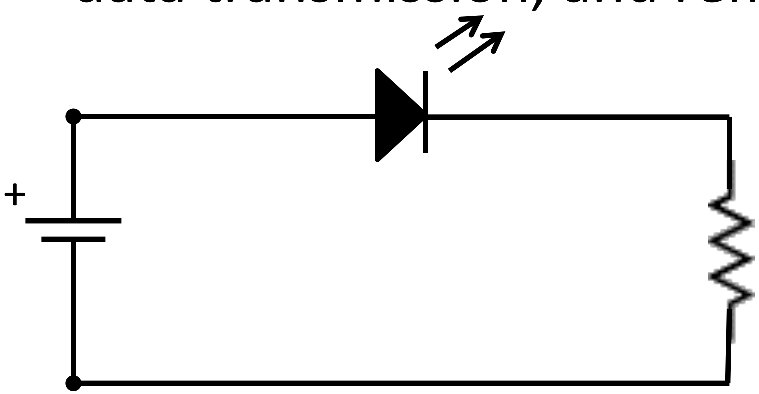


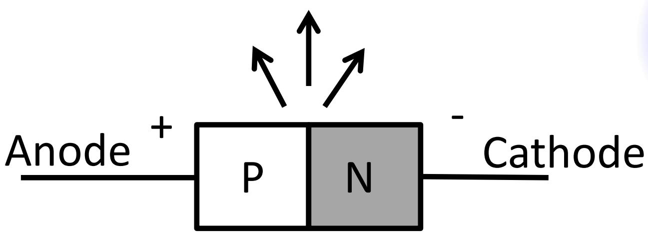
Light Emitting Diodes (LEDs)

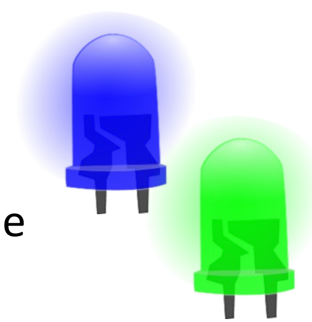
- **LED**s emits visible light when an electric current passes through it. LED have a transparent case that lets visible or Infrared light out. LEDs have a large PN-junction area whose shape is made to fit the application.

- Benefits of LEDs include low power, high efficiency and long life.

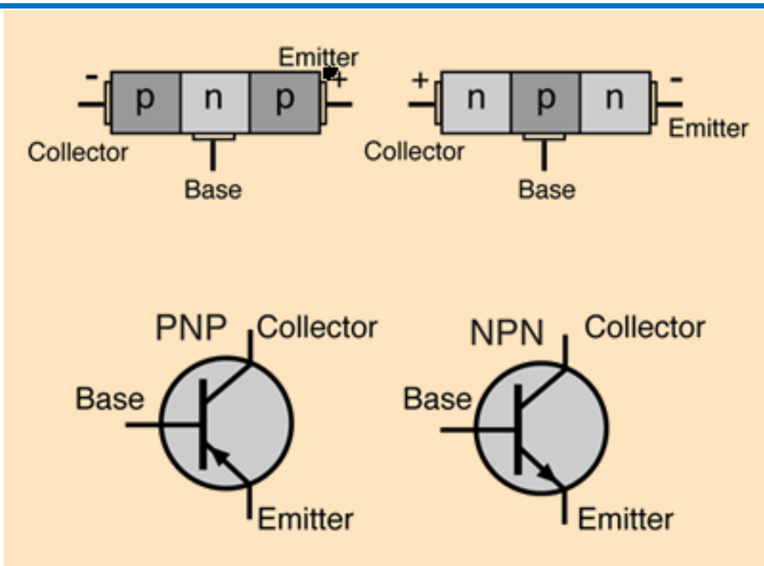
- Typical applications include indicator and panel lights, CD and DVD players, LCD flat-panel displays, opto-isolators, fiber optic data transmission, and remote controls.

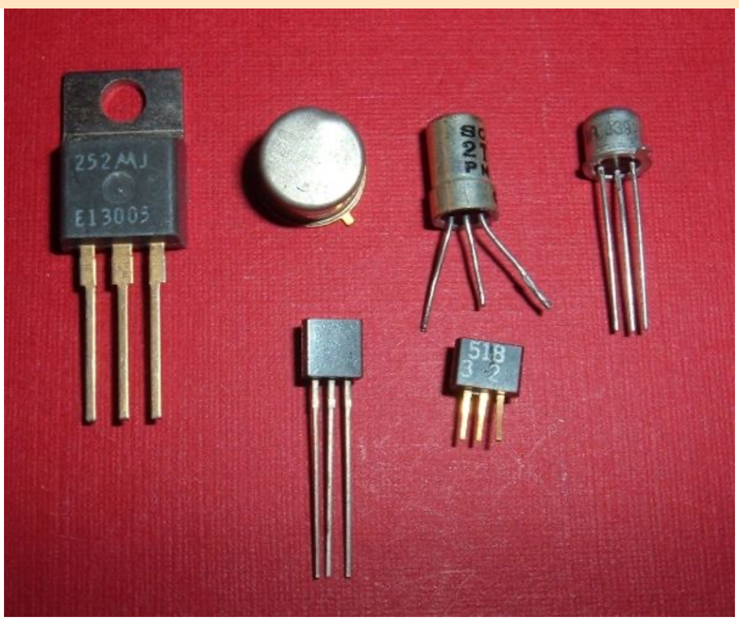






The Transistor





Invented in 1947 at Bell Laboratories.

Transistors revolutionized electronics.

Transistors can be switches or amplifiers.

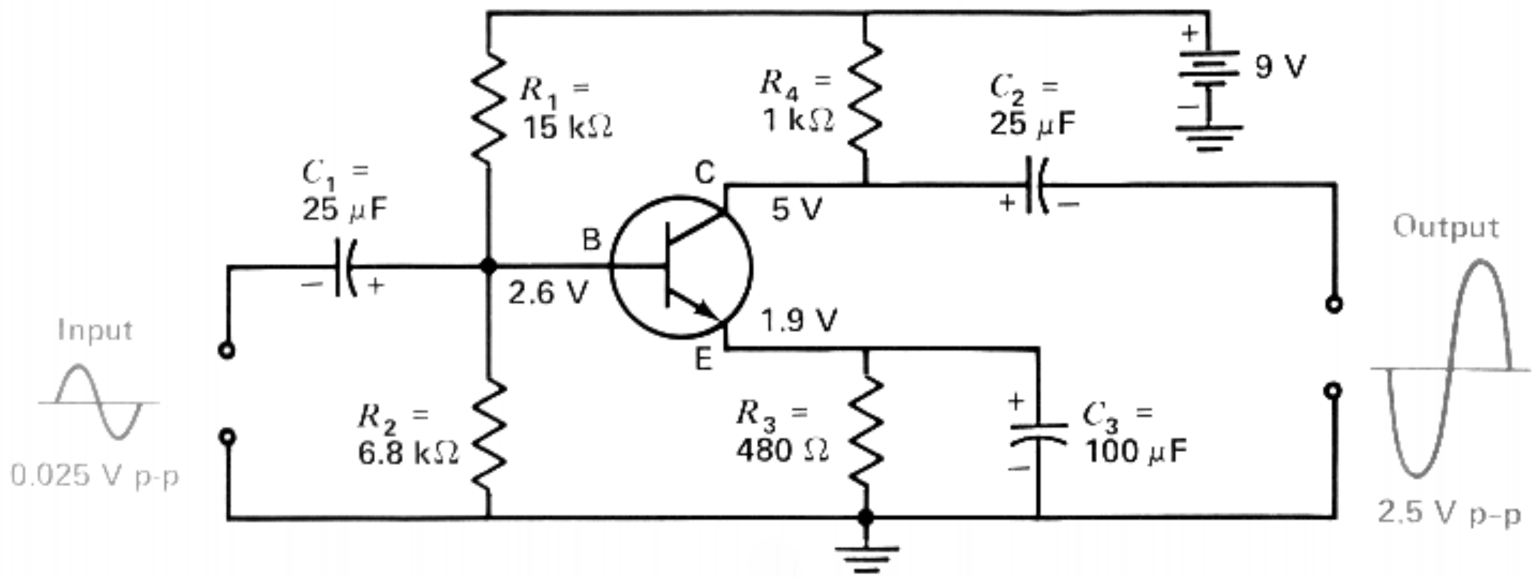
Transistors are used in all digital logic (computer) chips.

Transistors are used in almost every electronics circuit!

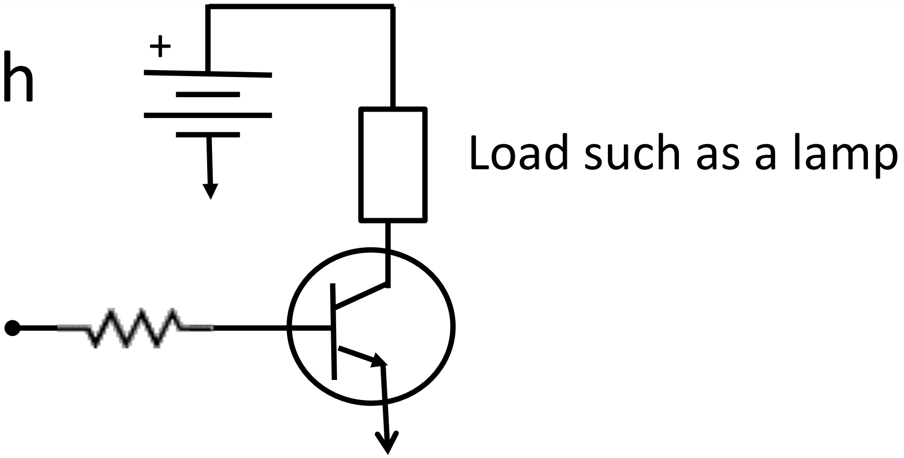
The Merit Badge patch is the symbol for the transistor

Transistors

Transistor as an Amplifier



Transistor as a Switch

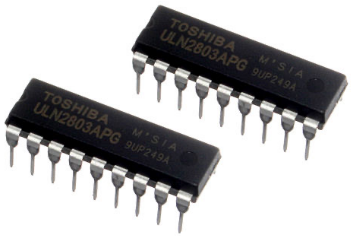


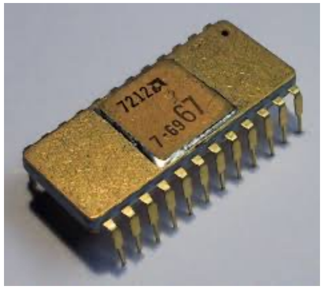
Integrated Circuits

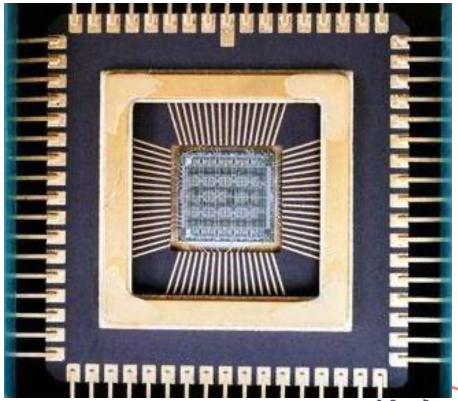
Integrated Circuits or IC's called Chips, have thousands to many millions of transistors, and diodes on a single semiconductor substrate.

Operational Amplifiers OPAMPS were the first IC's made.

In 1971, the first generation Intel microprocessor had 2,300 transistors and ran at 740 KHz. The latest fourth-gen Intel Core processor has 1.7 billion transistors and runs at 3 GHz.







Electronics Test Equipment

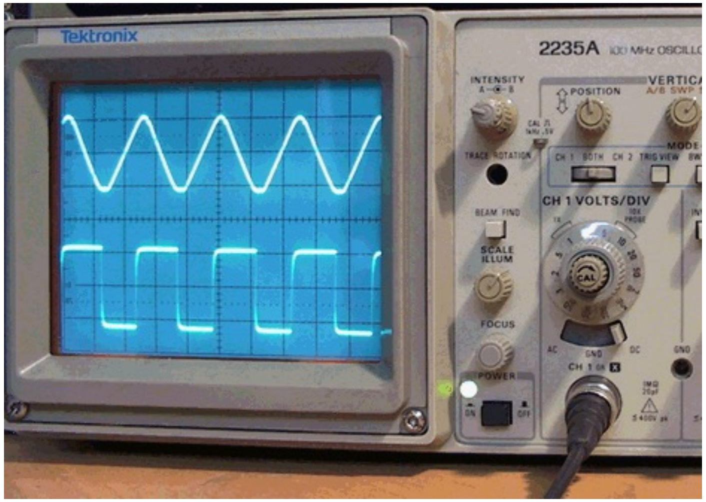
Volt/Ohm/Amp Meter

Usually referred to as a multi-meter.
With this we can measure current A, voltage V and resistance R.

Oscilloscope

Usually referred to as a Scope or O-Scope

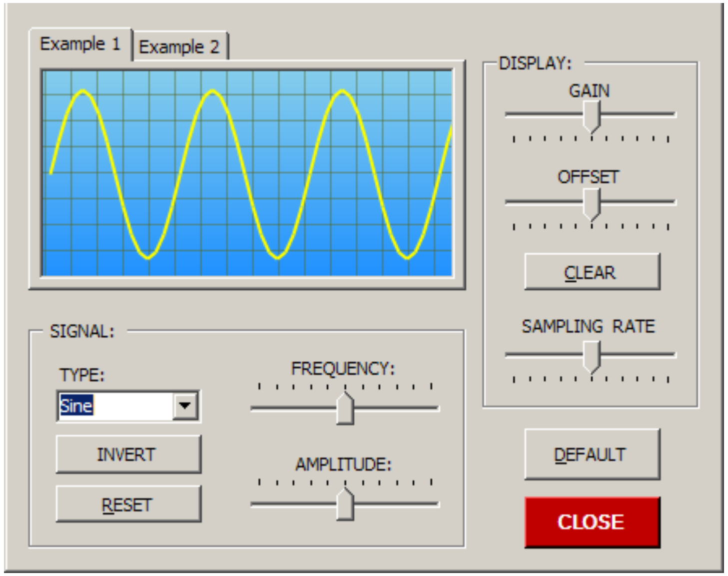
With this we can 'see' voltage wave forms. This is very useful when voltage is changing, as a meter is no good to us when this is happening.

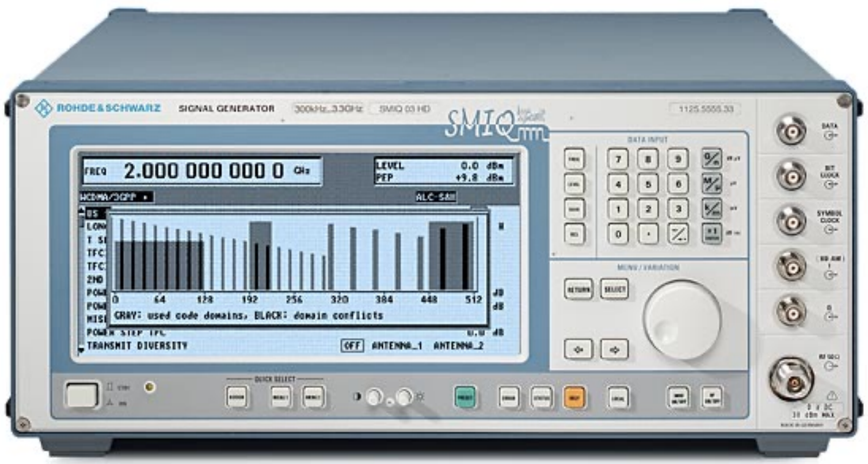


Electronics Test Equipment

Signal Generators

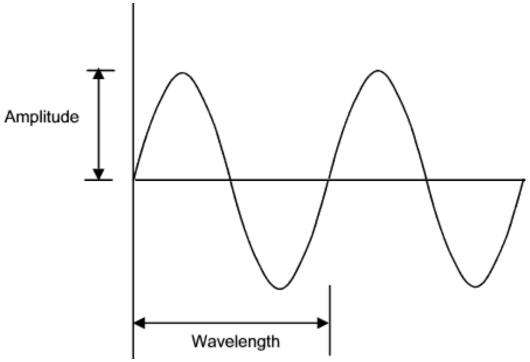
Signal generators are used to inject the proper type of electrical signal at various points in a circuit. Signal generators are used to troubleshoot problems and align communications circuits. Many of today's signal generators can be connected to a PC so that the diagnostics can be performed with the help of the computer.

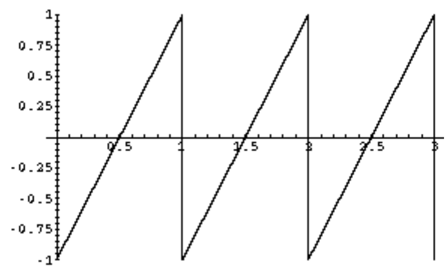


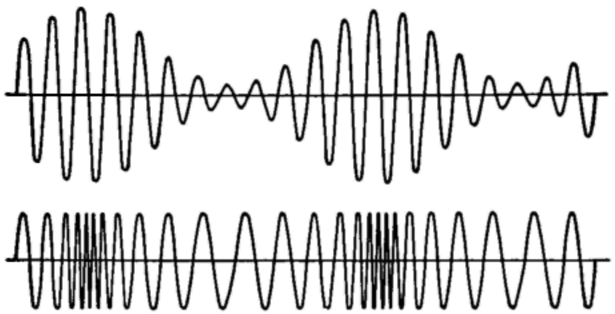


Analog and Digital Signals

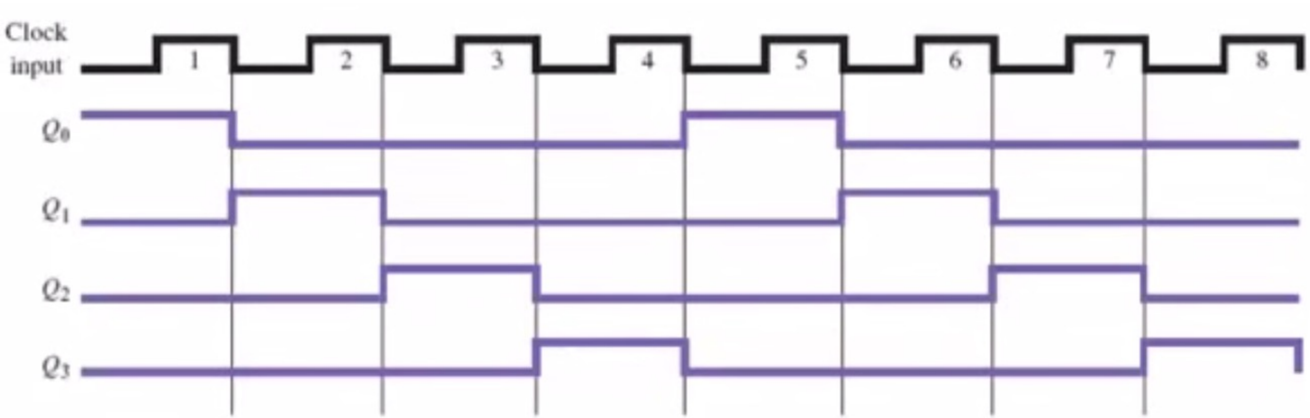
Analog – Amplitude, phase, frequency vary with time often in proportion to an input signal like from a microphone.







Digital signals use two voltage levels to represent 1's and 0's to perform logic and math functions. When an analog signals is converted to a Digital Signal, it's amplitude is replaced with a digital "number".



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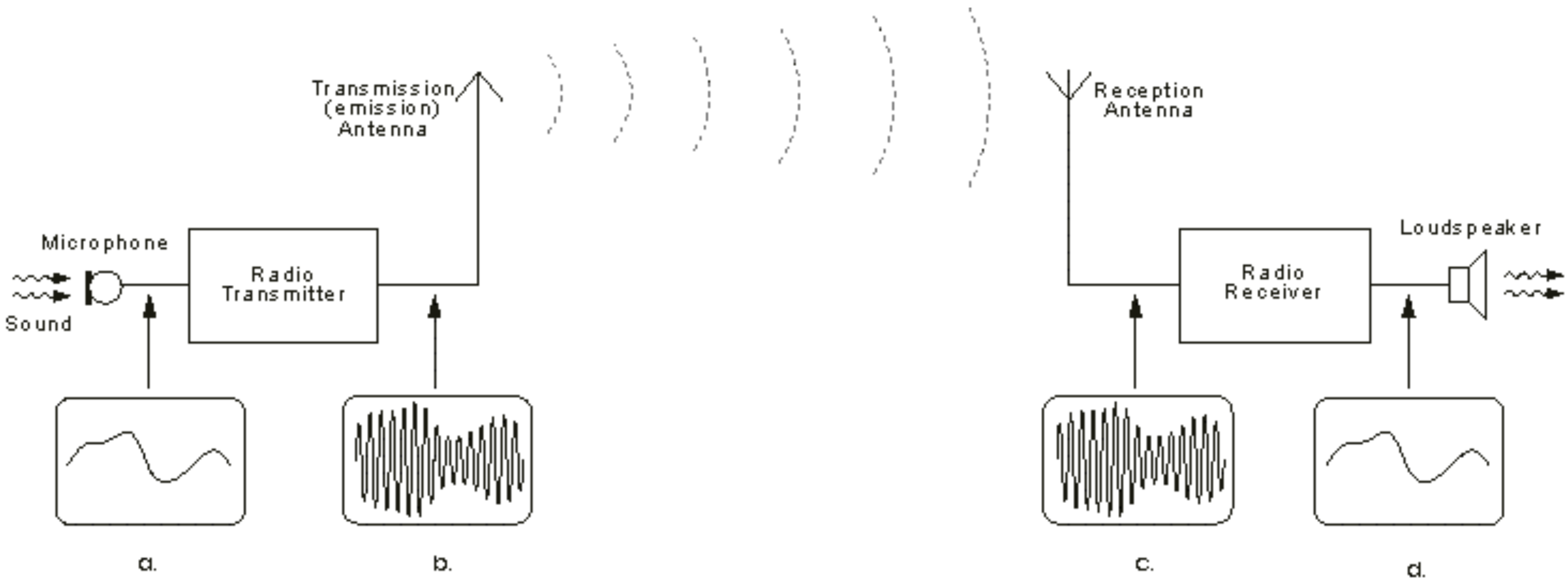
Radio

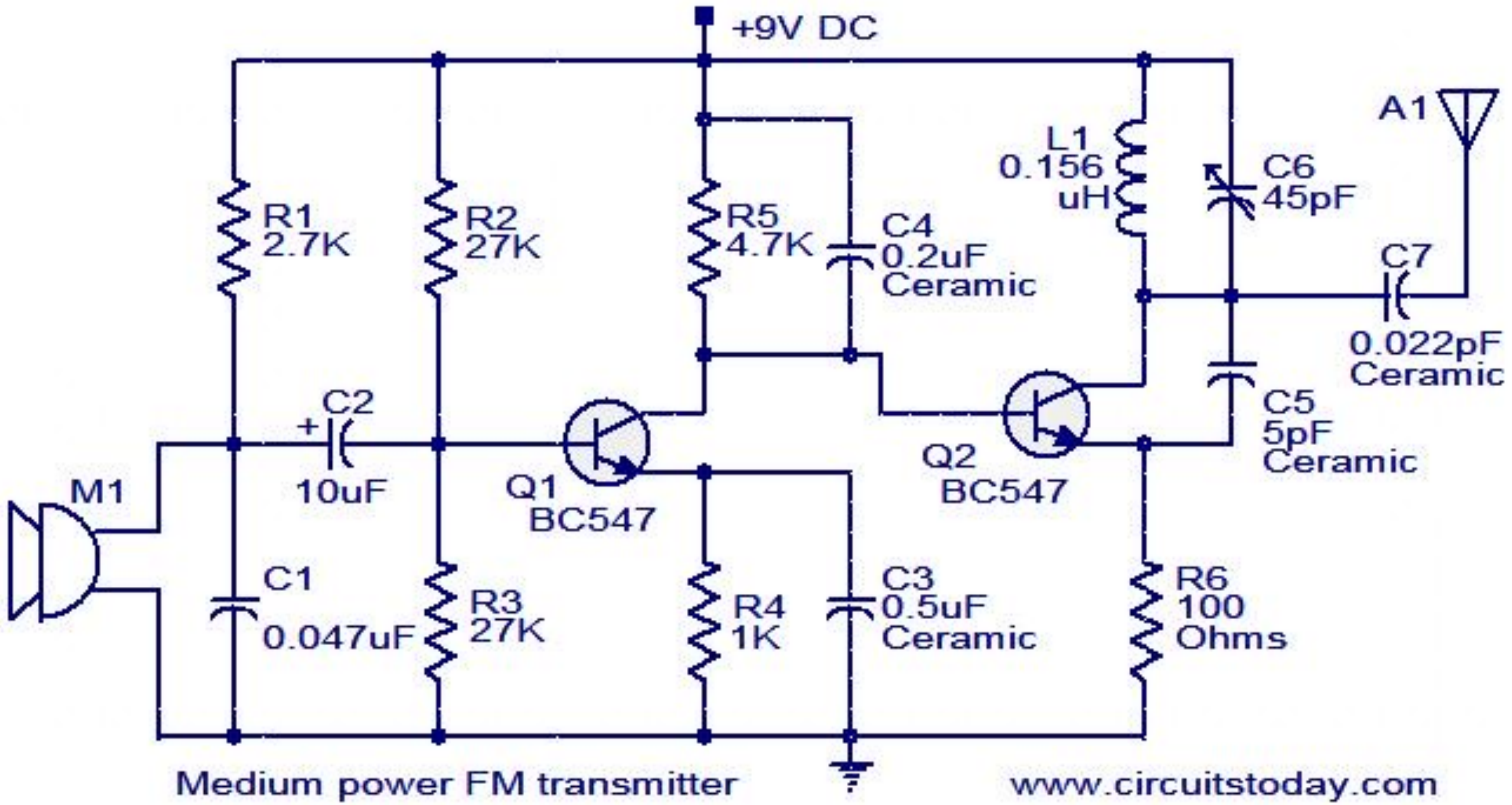


Modulator

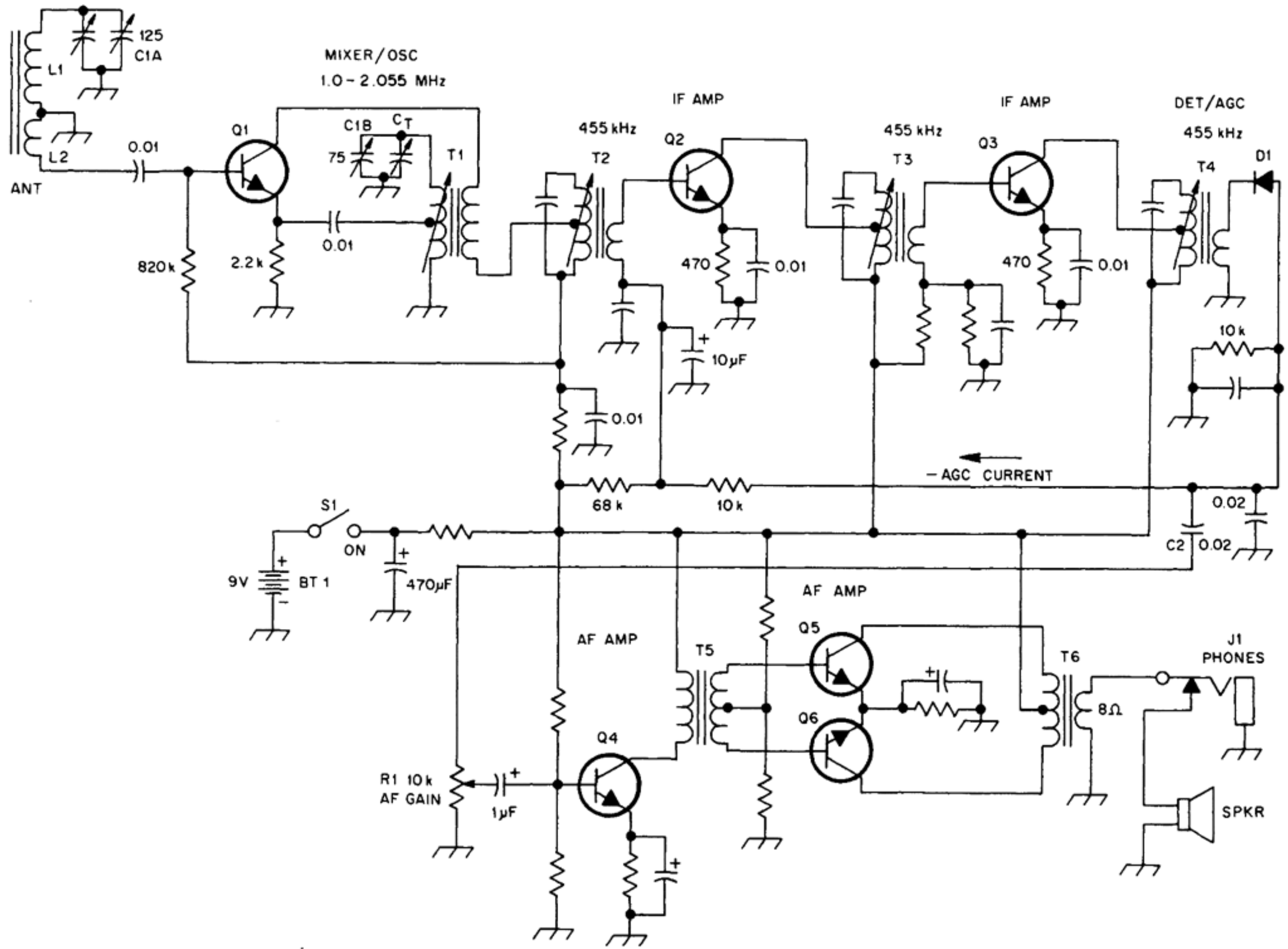
Pic.2.1.Radio Transmission Block-Diagram

Demodulator

FM Radio Transmitter



Radio Receiver



Digital Electronics

Computers use digital electronics.

Computers equate voltages with logical values. This is how electronic computer circuits can be made to do counting and other 'math' functions.

5 volts = logical 1   and   0 volts (ground) = logical 0

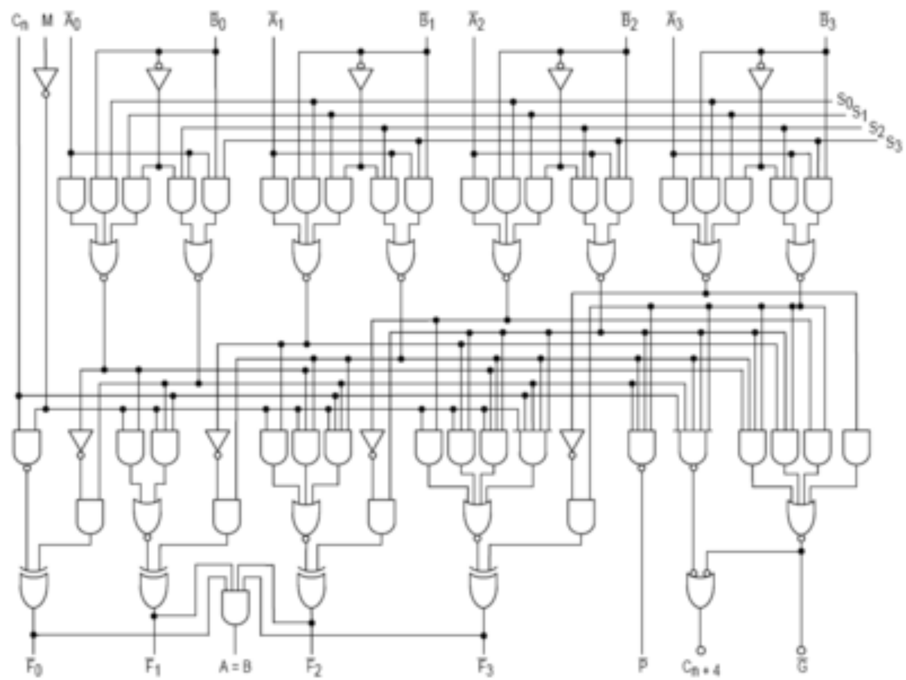
Computers use **Transistors** to act as logical switches to do counting.

Digital Electronics

A **BIT** is the basic unit of **DATA** in computing and digital electronics.

A **BYTE** is 8 BITS long. **WORD**s are made of Bytes- 2, 4 or 8 BYTES long .

Kilobyte (Kb) is 1,024 Bytes (1 Thousand)
Megabyte is 1,048,576 Bytes (1 Million)
Gigabyte is 1,073,741,824 Bytes (1 Billion)



Decimal – Base 10

- In base 10, there are 10 unique digits   0 1 2 3 4... 9
- Each number represents a value 10 times larger than the number to the right.
- There are numbers representing the 1’s, 10’s, 100’s, 1000’s etc.
- Example

1 2 3

1 – 100’s   2 - 10’s   3 - 1’s

One Hundred Twenty Three

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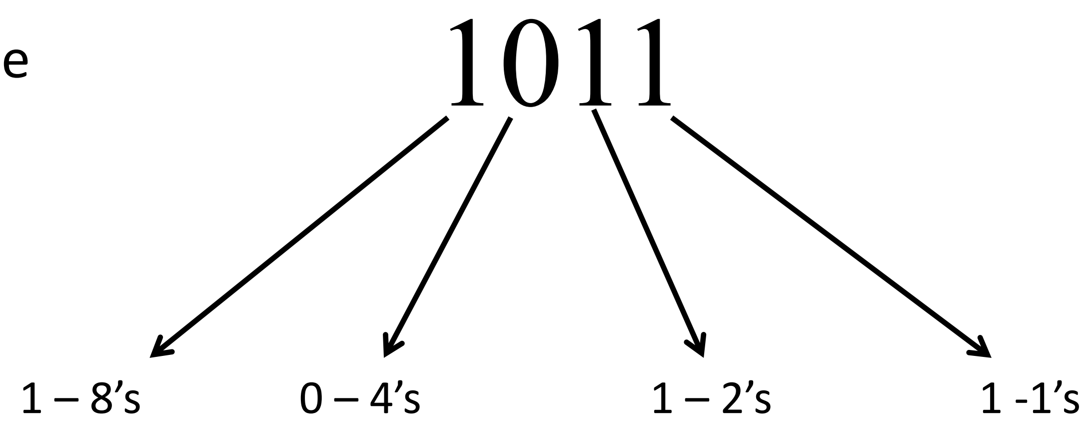
Binary – Base 2

- It's hard to count with digital logic in Base 10.
- In base 2 (binary) there are only two numbers: 0 and 1
- Each digit represents a value 2 times larger than the number to the right.
- There are numbers representing 1's, 2's, 4's, 8's, 16's, 32's, 64's 128s, etc
- Example



1x8 + 0x4 + 1x2 + 1x1 = 11 Base 10

Counting to 16 in Binary

base 10 number		16	8	4	2	1	Binary
0		0	0	0	0	0	00000
1		0	0	0	0	1	00001
2		0	0	0	1	0	00010
3		0	0	0	1	1	00011
4		0	0	1	0	0	00100
5		0	0	1	0	1	00101
6		0	0	1	1	0	00110
7		0	0	1	1	1	00111
8		0	1	0	0	0	01000
9		0	1	0	0	1	01001
10		0	1	0	1	0	01010
11		0	1	0	1	1	01011
12		0	1	1	0	0	01100
13		0	1	1	0	1	01101
14		0	1	1	1	0	01110
15		0	1	1	1	1	01111
16		1	0	0	0	0	10000

Decimal to Binary Worksheet

Decimal		Binary				
		8	4	2	1	
10	=	1	0	1	0	8 + 2 = 10
_____	=	0	0	1	1	
_____	=	0	1	0	1	
6	=	__	__	__	__	
9	=	__	__	__	__	

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Decimal to Binary Worksheet

Solution

Decimal		8	4	2	1	
10	=	1	0	1	0	8 + 2 = 10
3	=	0	0	1	1	
5	=	0	1	0	1	
6	=	__	1	1	__	
9	=	1	__	__	1	

Binary

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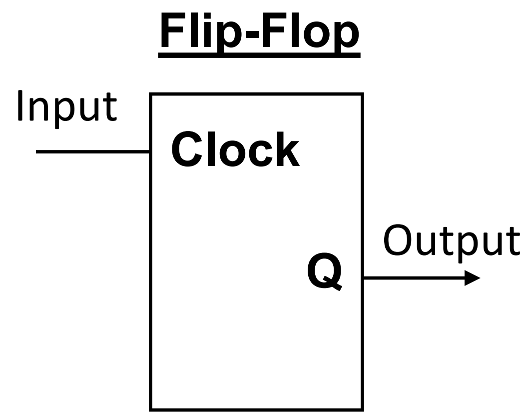
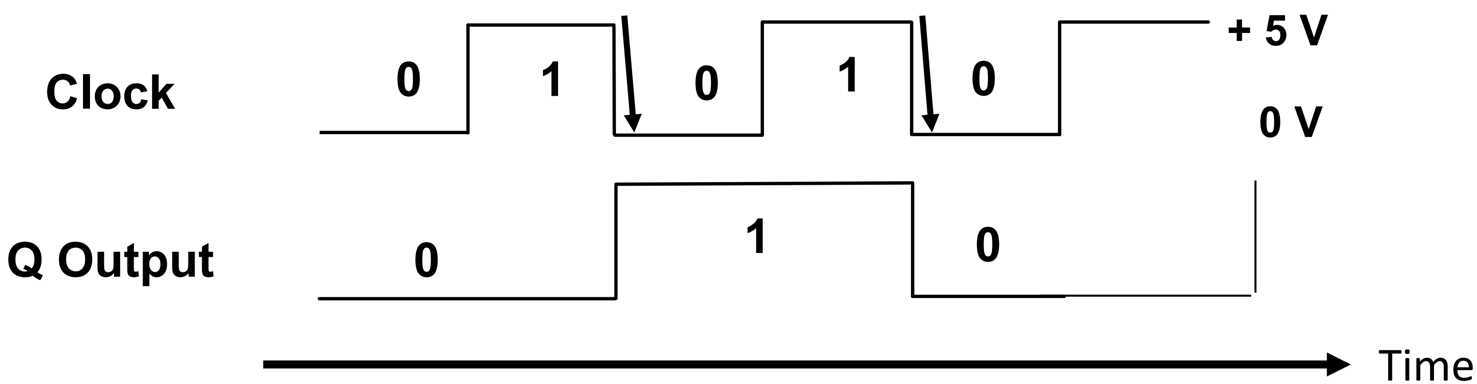
Digital Logic

FLIP-FLOP

A flip-flop divides a clock signal by 2.
It takes 2 clock transitions to make the output change once.

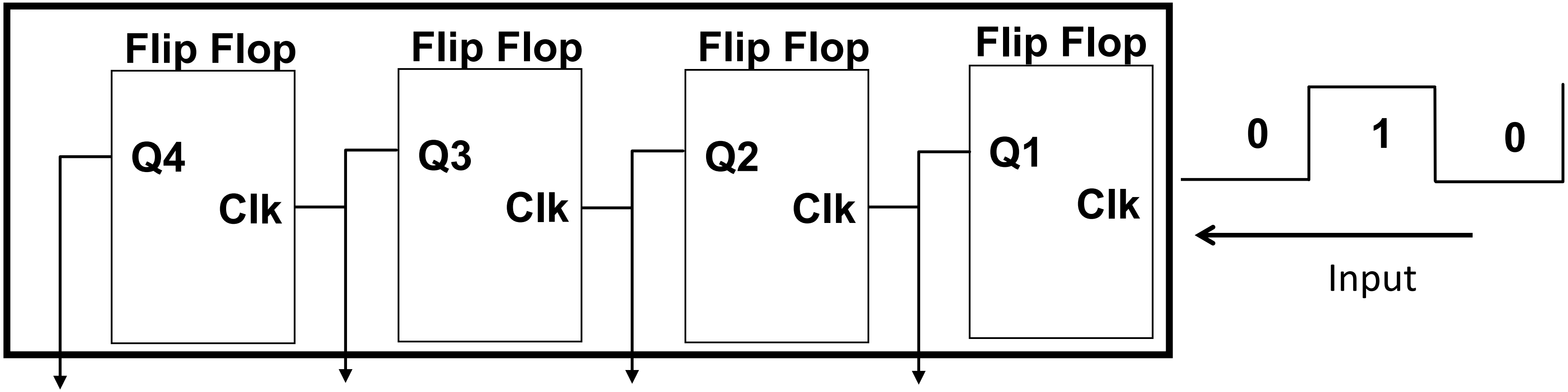
The clock signal is at 0 volts (logical 0).
The clock signal switches to 5 volts (logical 1).
The clock signal switches back to 0 volts.
Then the output (Q) changes state. on each 1 to 0 transition of the clock.





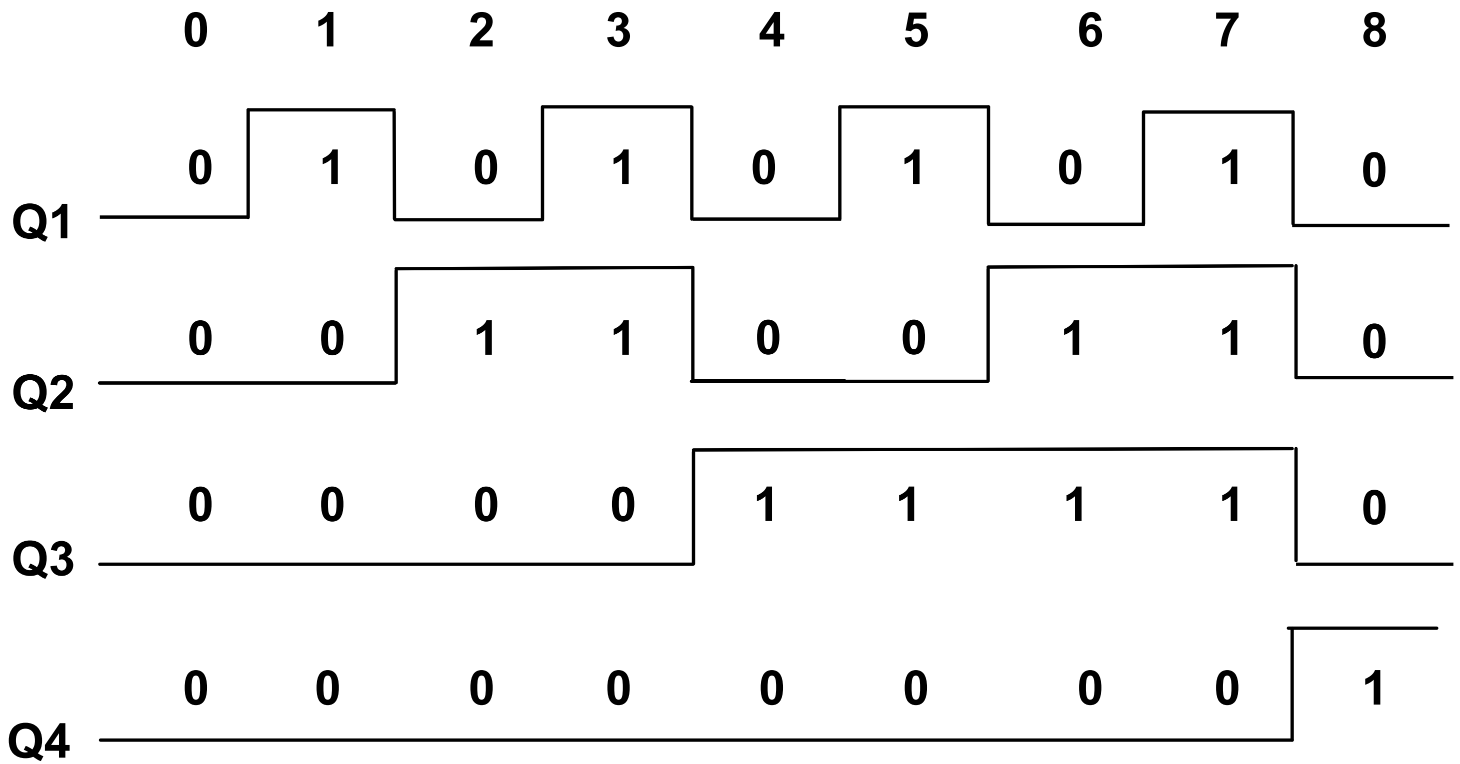
A Counter Using Flip-Flops

4 Bit Binary Counter



Binary				**Decimal**
0	**0**	**0**	**0**	**0**
0	**0**	**0**	**1**	**1**
0	**0**	**1**	**0**	**2**
0	**0**	**1**	**1**	**3**
0	**1**	**0**	**0**	**4**
0	**1**	**0**	**1**	**5**
0	**1**	**1**	**0**	**6**
Bit 4	**Bit 3**	**Bit 2**	**Bit 1**	

Digital Counting



Electricity Safety

- Voltage at 120V AC or greater – Safety mainly about not touching the wrong thing.


- Current kills – Only 60 volts can kill when current flows through heart or head for a sufficient length of time.

- Ventricular fibrillation - Current passing through heart causes knocks heart out of synchronization.

- If the shock doesn't kill you, you can still be badly burned from touching the wrong thing.

Electronics Safety

- Electronics generally uses lower voltages (less than 30 volts). You are usually working with DC battery voltage instead of AC line voltage.
- You are usually more concerned with sparks from connecting wrong wires together or burning yourself with a soldering iron.
- Even when working with lower voltages, you may still receive an electrical shock from equipment you are using, especially when they are plugged into a 120 volt AC outlet.
- Capacitors store charge and can shock or burn you. Discharge power supply capacitors or high voltage capacitors with a resistor before working on any circuit. Observe the “one-hand” rule if reaching into an electronics cabinet..
- Do not wear jewelry like rings or watches when working in electronic cabinets.

Electronics Safety

- **THINK** before you do something. **Ask**: Is the power on? **Be sure** the electricity is turned **OFF** especially when working on 120 VAC or higher.

- Be concerned with **Sparks** from connecting wrong wires together but even when working with low voltages you can still get an electrical shock or burn. **Sparks** and **Short Circuits** can start a **Fire**.

- **NEVER** put **WATER** on an **Electrical Fire**! Use a Class C Fire Extinguisher

- Soldering Irons are **HOT** – more than **374 degrees F** –they will burn you or start a fire!

- **ALWAYS Wear safety glasses when soldering** Hot Solder can splatter. Clipped wires can go flying. Protect your eyes!

Soldering

*Safety Note: A Soldering Iron gets hotter than **374 F.***
Do not touch the soldering iron's metal parts or you will receive a third degree burn.
Wear safety glasses when soldering.

A good solder joint depends on the following:

1) Solder iron must have a clean, well-tinned tip. Tin the tip by wiping the heated tip on the sponge, and then applying fresh solder to the tip. This will allow for a better heat transfer from the tip to the PC board.

2) Parts to be soldered must be clean.

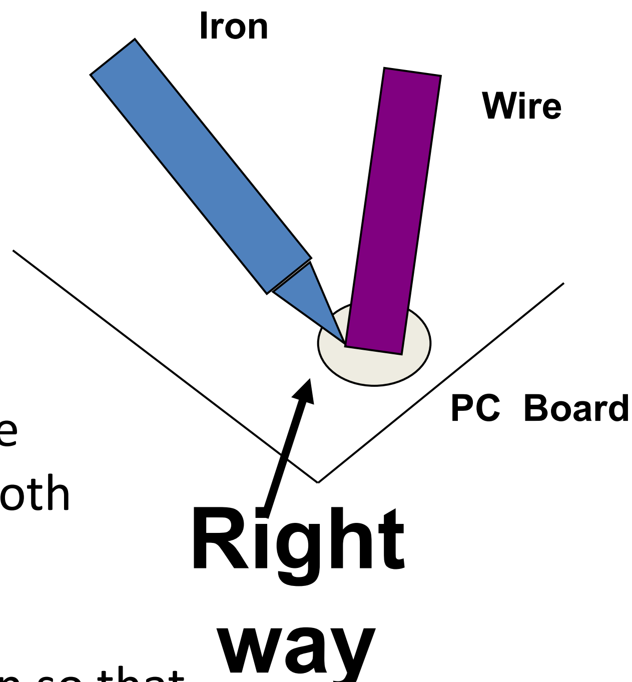
3) There must be a sound mechanical joint.

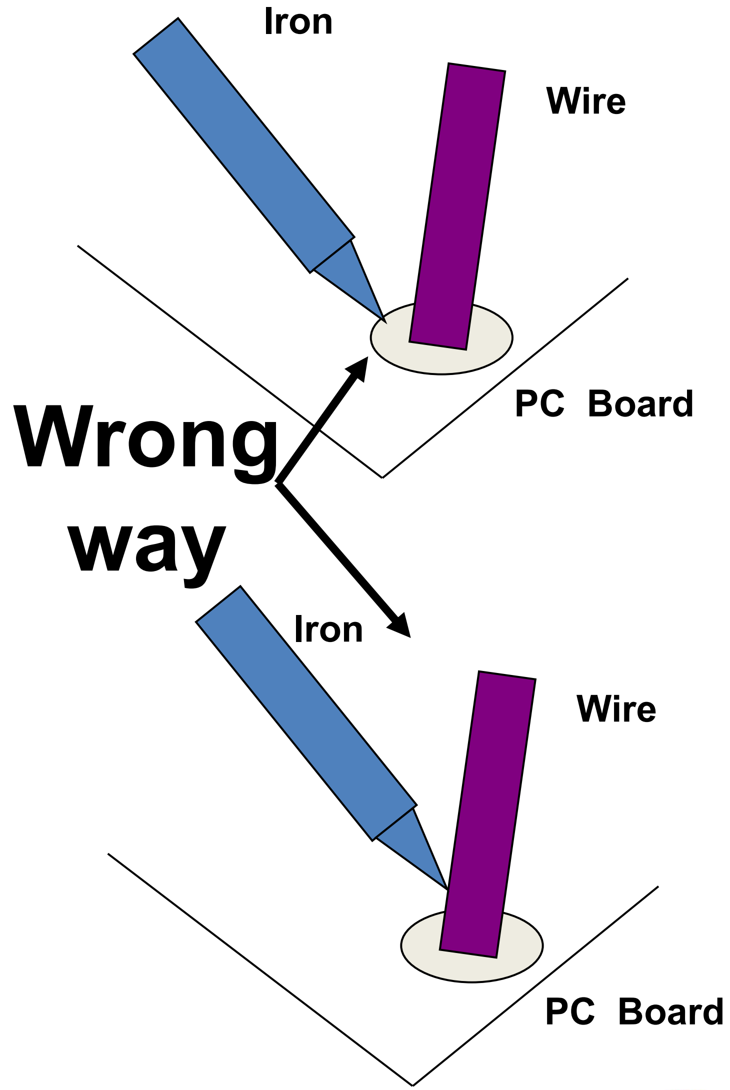
4) Parts to be soldered must be well heated before applying solder.

5) Wait approx. 5 seconds after soldering to allow strong mechanical joint to form.

Soldering

Solder melts at 374 F. So the wire and PC board must be the same temperature for the solder to melt on both items.

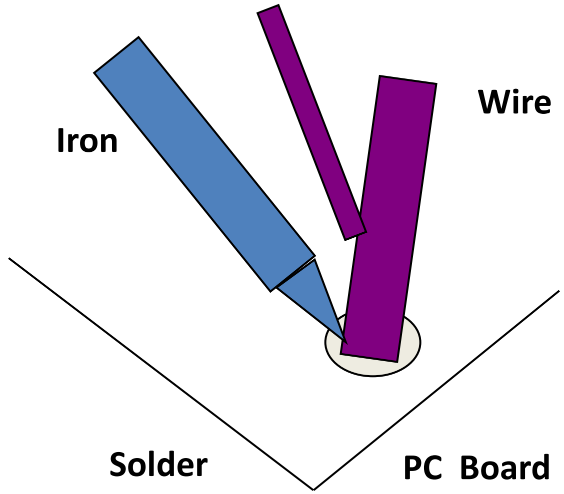




Place soldering <u>iron so that it touches both the PC board and wire.</u> The heat from the soldering iron will transfer to the PC board and wire at the same time.

Soldering

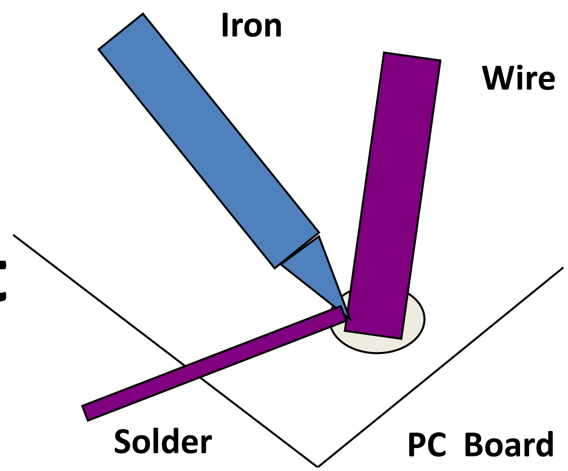
Wrong way



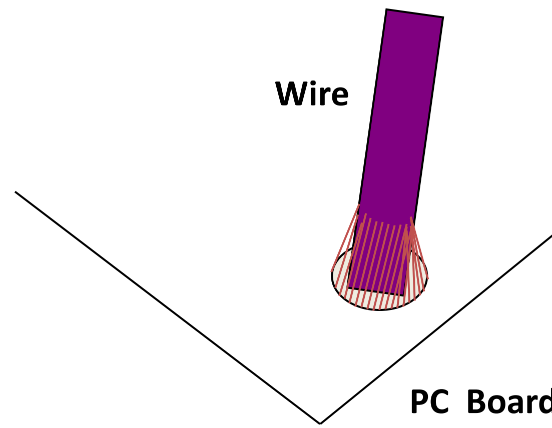
After 3 seconds place the solder on the tip of the <u>iron, the wire, and the PC board all together.</u>

The solder should flow to everything making a good connection.

Right way



When the board and wire are hot enough, the solder will flow and create a cone shape. If the board is not hot enough the solder will be rounded on the board, creating somewhat of a ball. The finished solder joint should also be shiny.



Un-Soldering

1. Use pliers to hold the *body* of the component to be removed. If the *lead* is held with the pliers it will draw heat from the lead, and you may damage the part and possibly the board.

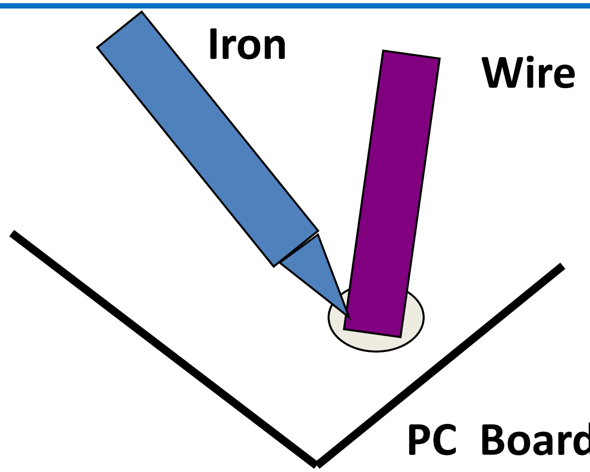
2. Apply soldering iron tip to printed circuit board and the component lead. It is common to add a little fresh solder to the lead and board, to improve heat transfer.

3. Using the pliers, simply pull the component lead from PC board while holding the soldering iron on the lead.

4. The soldering Iron will damage electronic components if left on device for greater than 15 seconds, so work quickly.

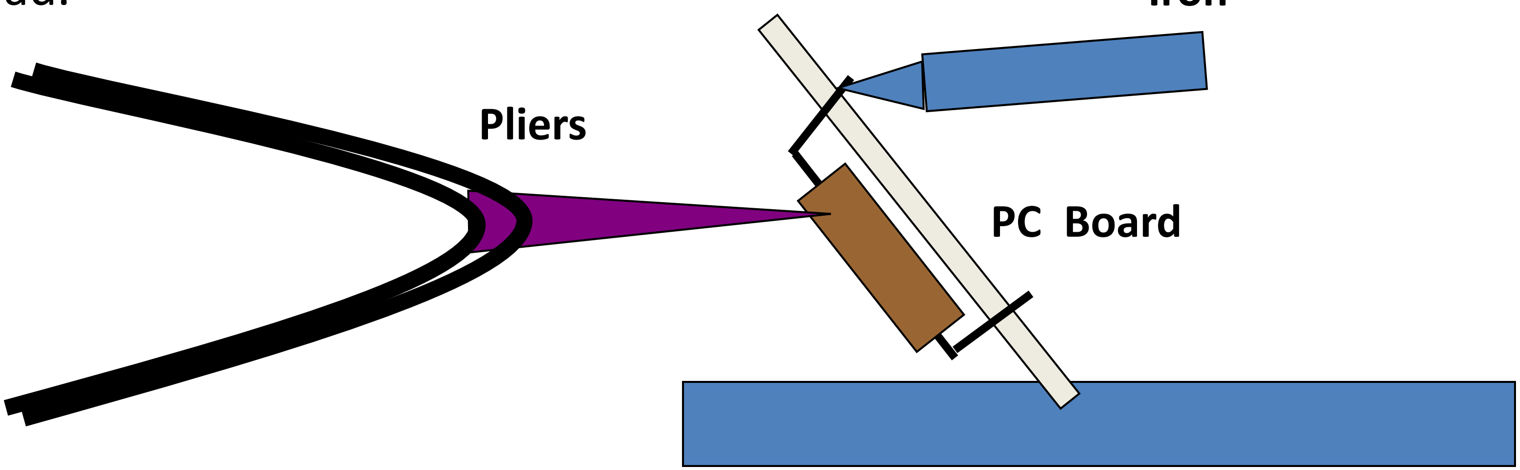
5. Clean soldering iron tip and keep it shiny.

Un-Soldering



Unsolder one component from the board.

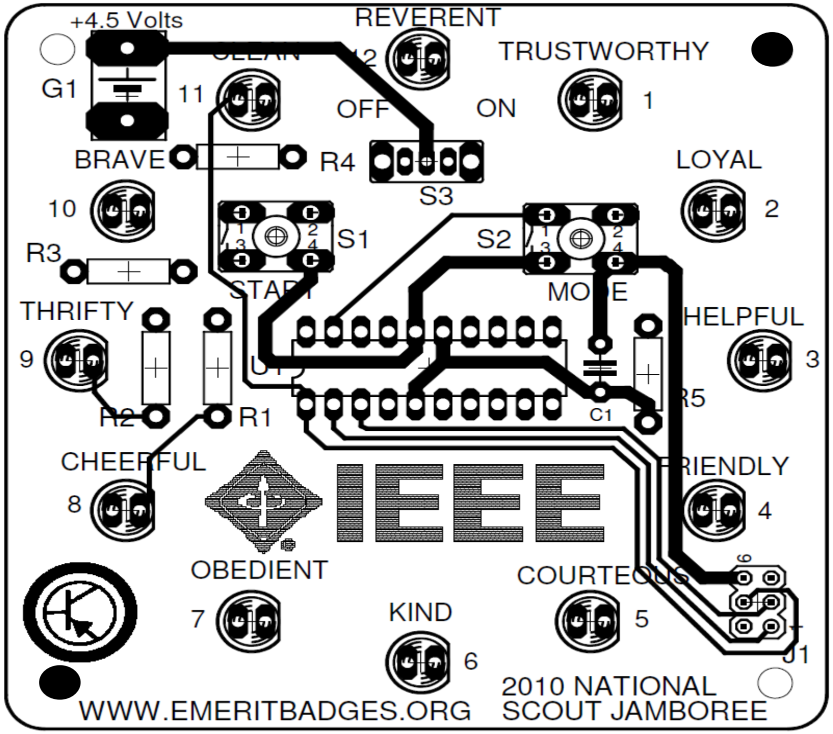
With pliers, hold the body of the part to be unsoldered. As heat is applied, pull the lead from the board by pulling on the body. Repeat for second lead.



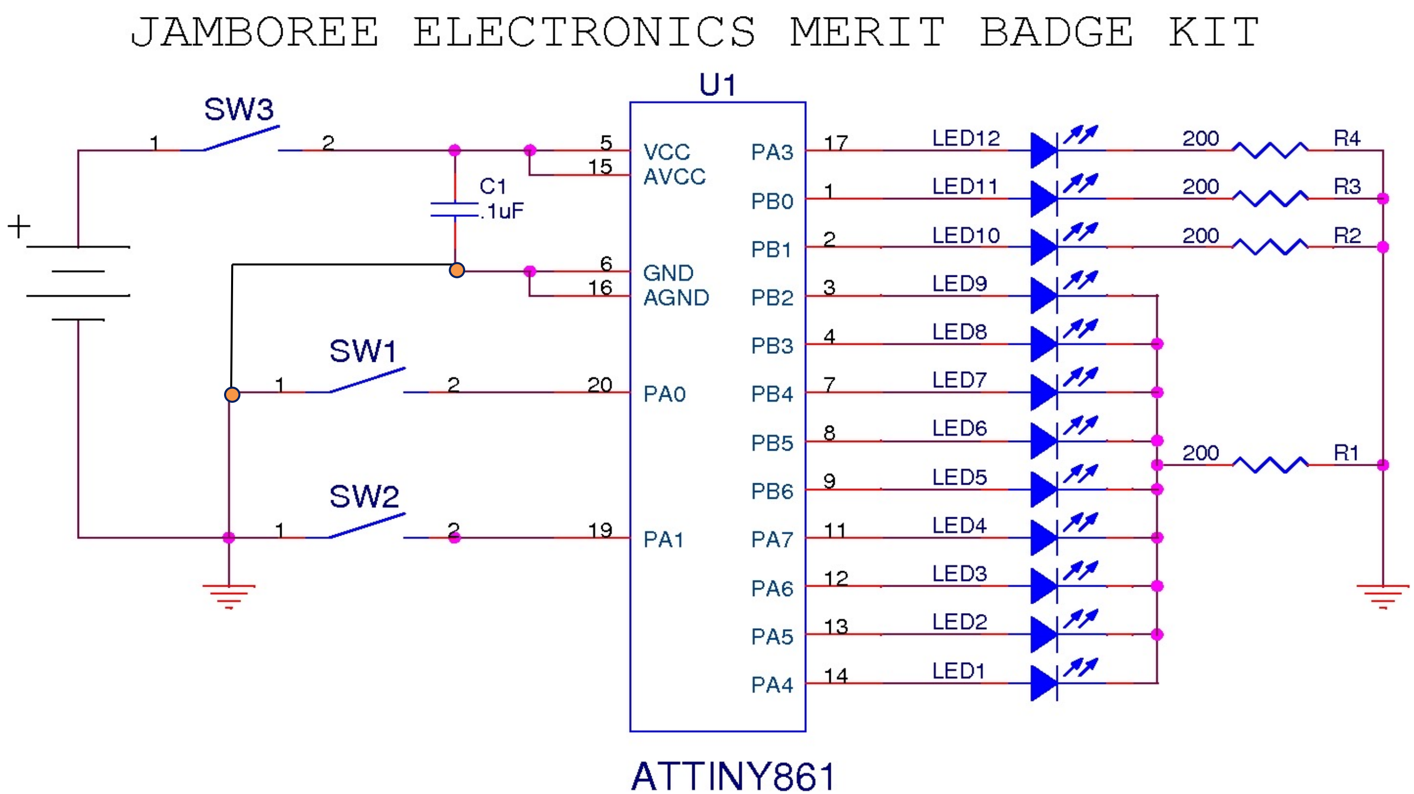
Microprocessor Controlled Counter

The kit contains a microprocessor that will light 12 LEDs in a diminishing pattern.

The LEDs can be displayed in several different modes, though each mode starts as a fast pattern and slows to a stop.

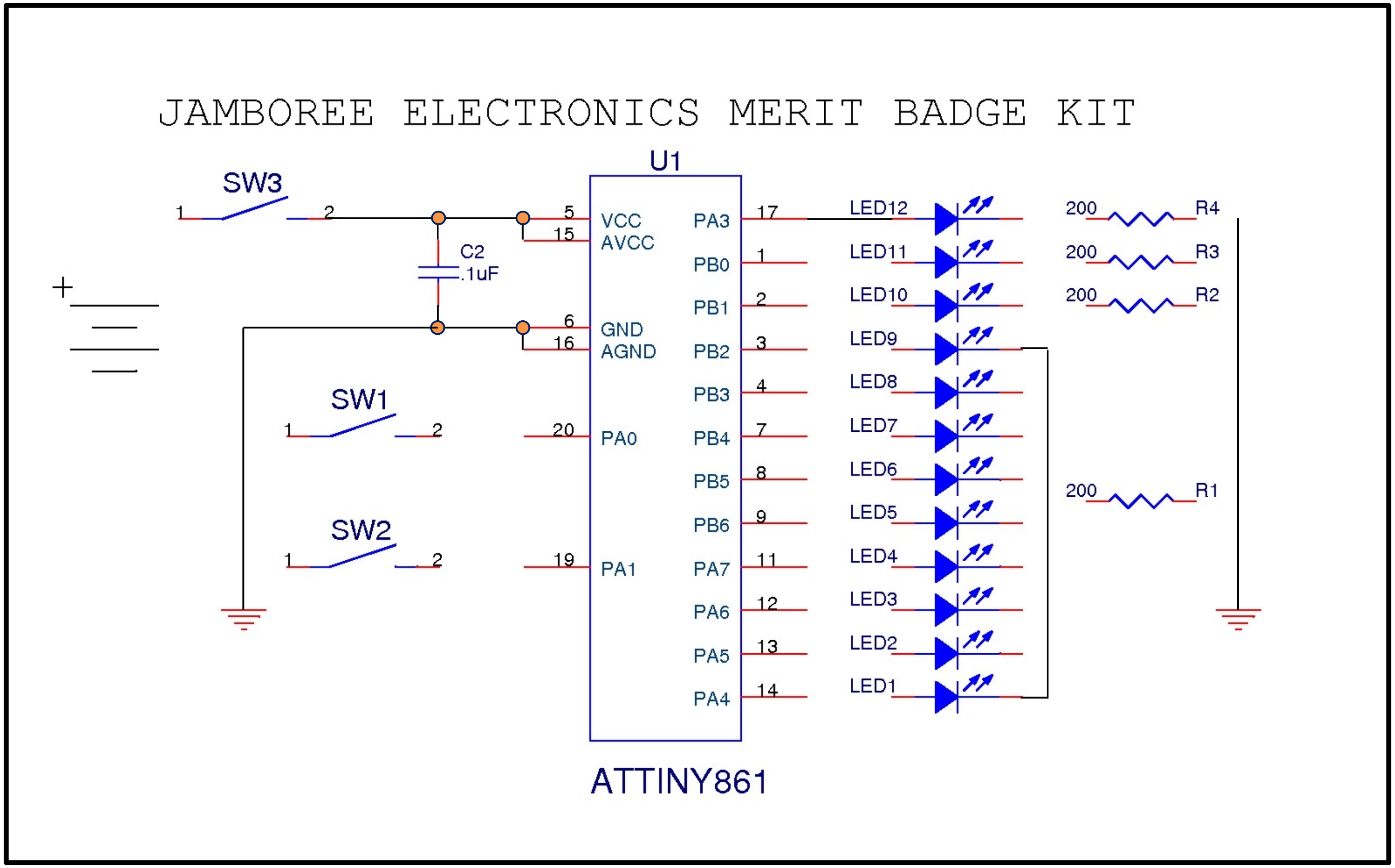


Microprocessor Controlled Counter Schematic



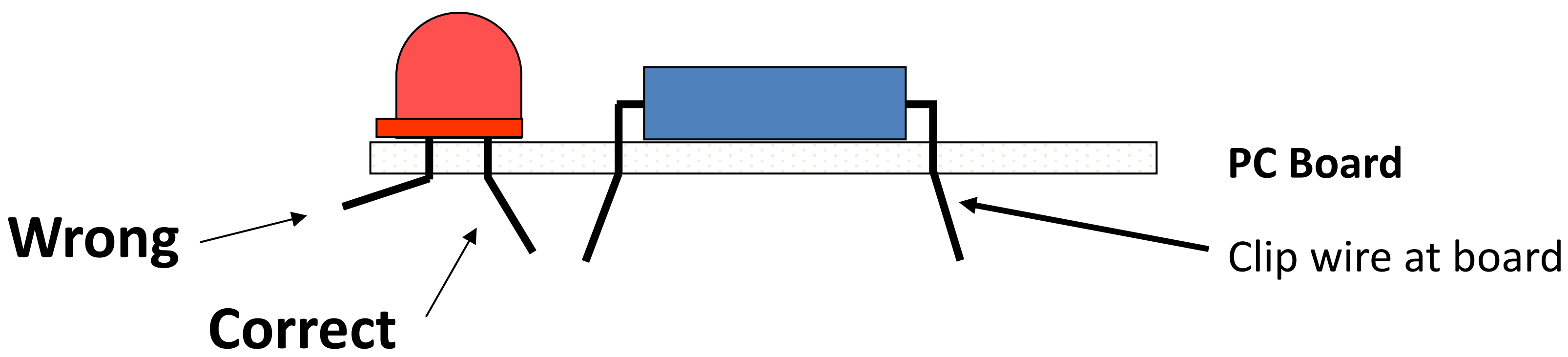
Microprocessor Controlled Counter Schematic

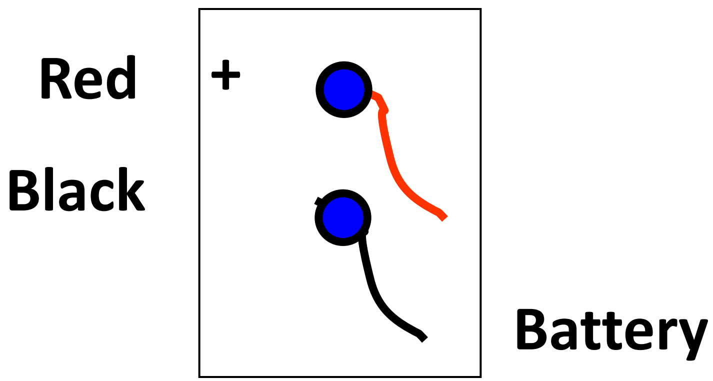
Draw the Schematic / Connect the lines

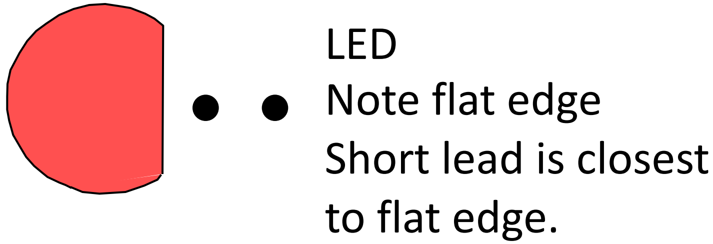


Soldering Kit

1. Place components into PC board in the order recommended on instruction sheet
2. Bend leads out slightly to keep parts in place.
3. Follow instructions as to proper orientation of components.



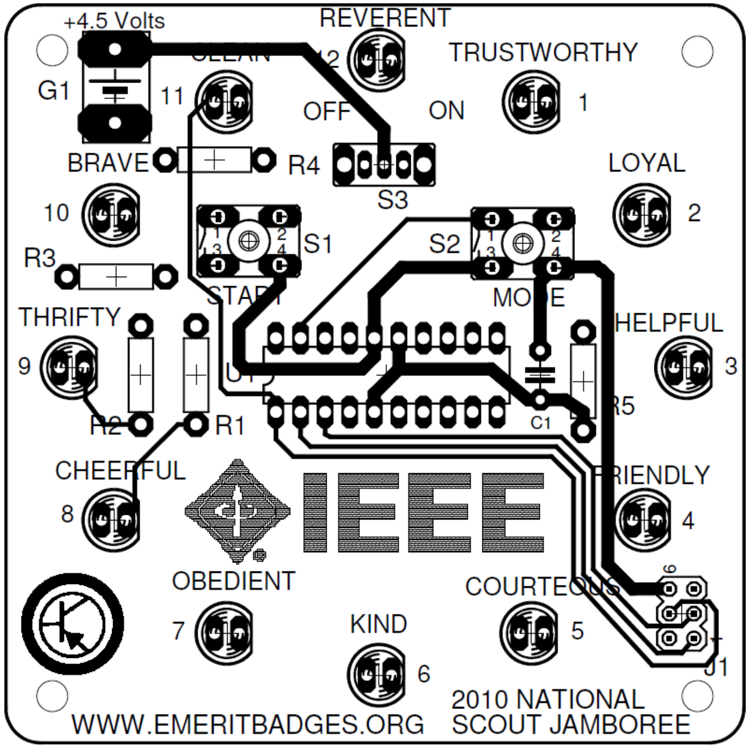




Microprocessor Controlled Counter Kit

The kit contains:

1. PC board
2. 1 Microprocessor – Atmel ATTINY861-20PU (U1)
3. 5 resistors R1-R4 = 200Ω, R5=56KΩ
4. 1 Capacitor C1 =.01uf
5. 12 LED's
6. 2 push buttons S1 & S2
7. 1 slide switch S3
8. 1 battery holder
9. 1 box with 2 screws

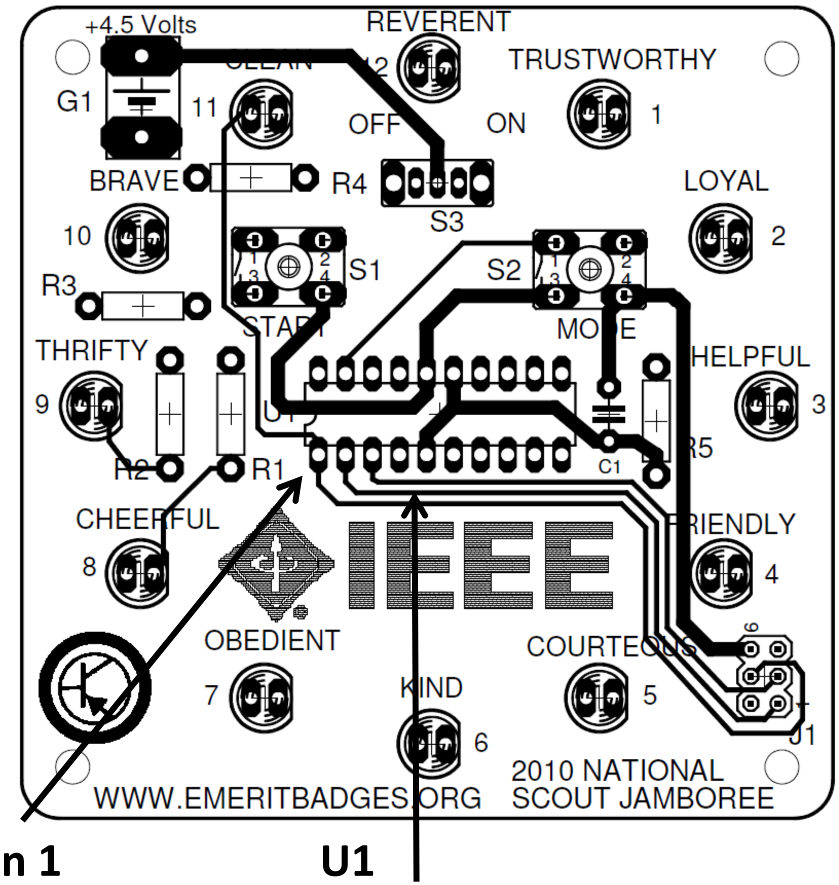


Microprocessor Controlled Counter Kit

Assembly Sequence

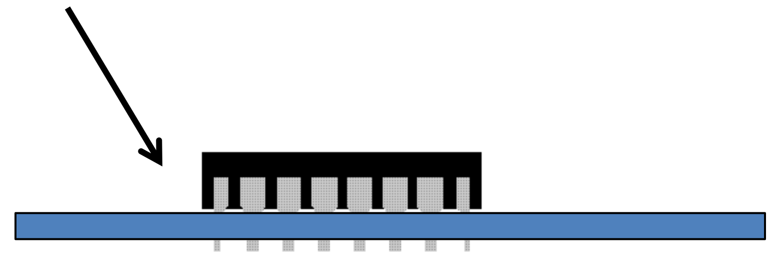
1. Place U1 on board. Note pin 1 orientation. Solder component into place.
2. Place resistors in board, bend leads out and solder, then cut leads.
3. Place all LEDs in board, bend leads out and solder, then cut leads.
4. Place capacitor in board, bend leads out and solder, then cut leads.
5. Place Switch S1, S2 & S3 in board and solder.
6. Place Red and Black battery wires from the back of the board and solder.
7. Place battery in box and cover with PC board
8. Use two screws to secure the PC board to box.

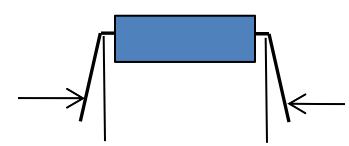
Microprocessor Controlled Counter Kit



Pin 1 **U1**

Insert U1 into proper position on the board. Leads should come out the bottom of the board.





Solder 20-pin DIP (Microprocessor) in U1 location. Orient U1 so that pin 1 is on the left.

Note: You will need to bend all leads on each side to be more perpendicular to body of the component, before inserting the leads in the board.

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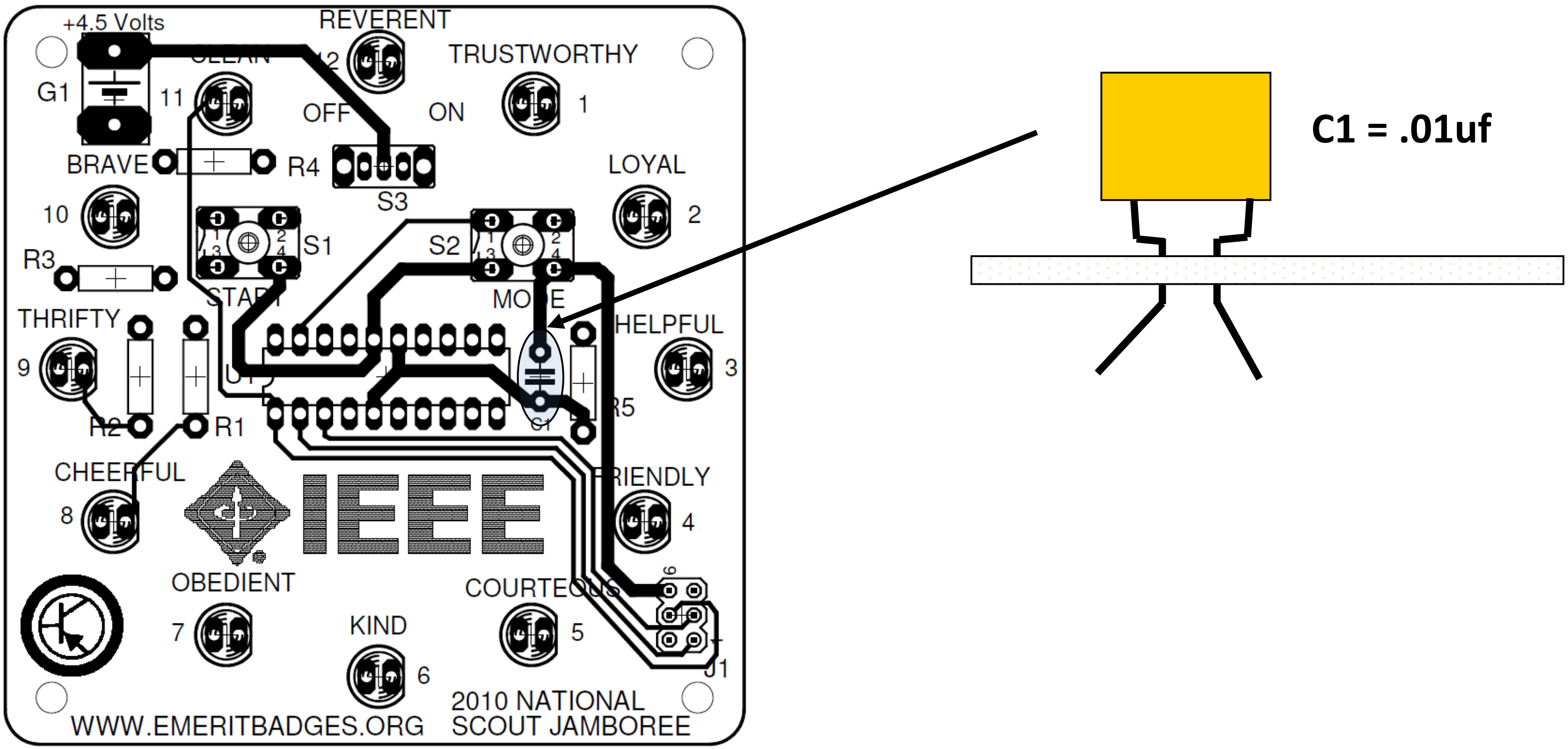
Microprocessor Controlled Counter Kit



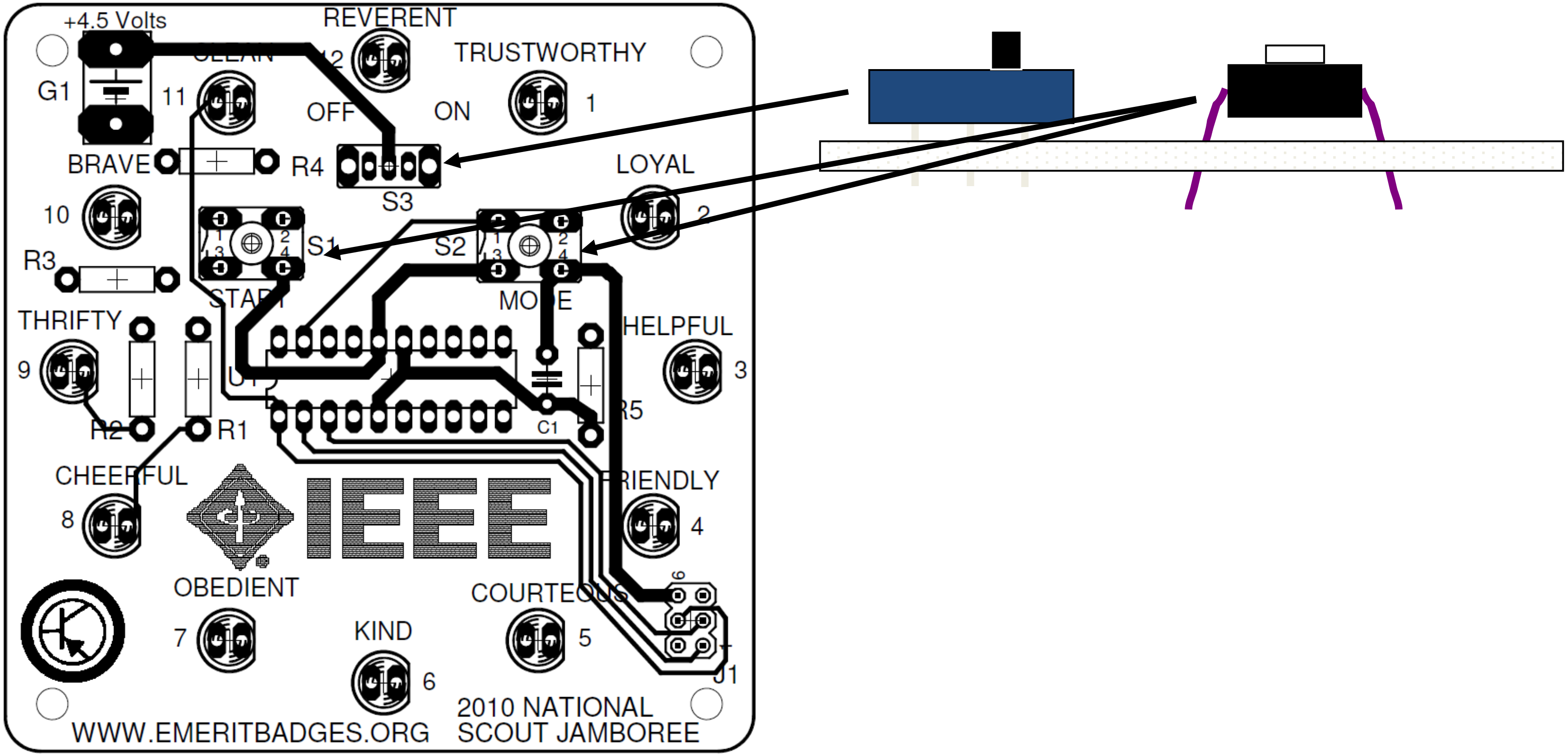
Place capacitor at C1.

Orientation of capacitor does not matter.

Bend leads out.

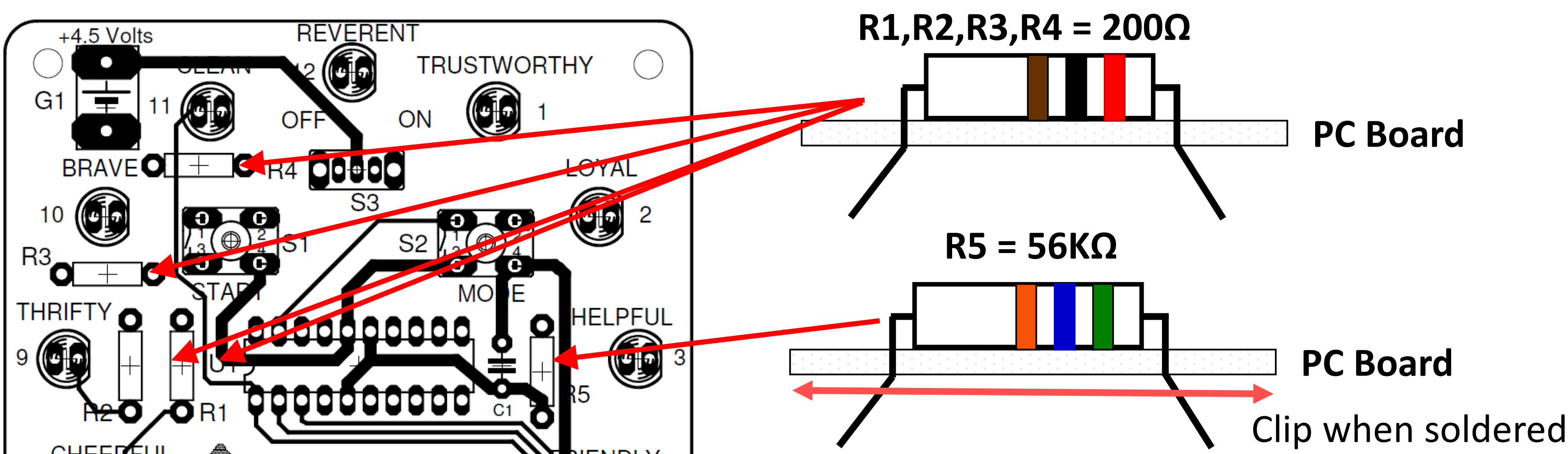
Solder leads. Carefully clip leads when done.

Microprocessor Controlled Counter Kit



Place Switches S1, S2 and S3 in their appropriate positions and solder.
Make sure S3 (slide switch) is vertical, before soldering all the leads.

Microprocessor Controlled Counter Kit



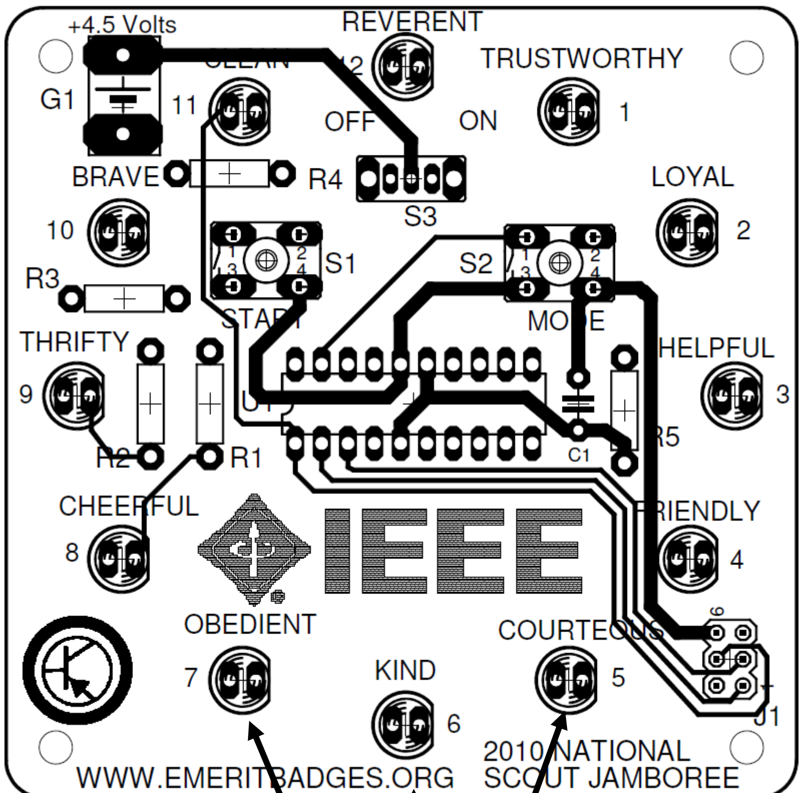
R1-R4	**200Ω, (red, black, brown)**
R5	**56KΩ, (green, blue, orange)**

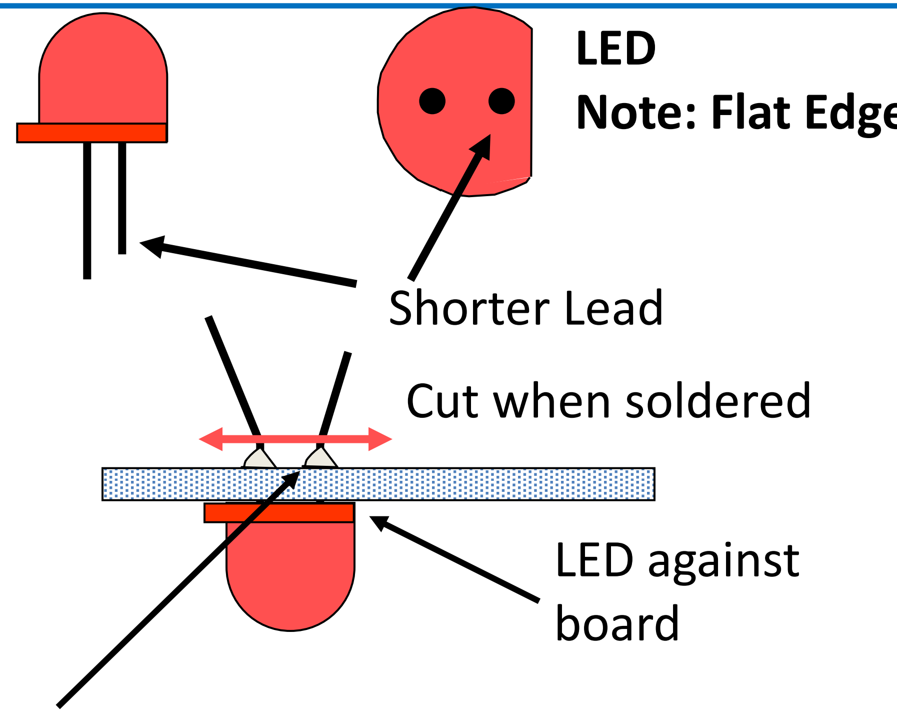
Place resistors onto board. Direction of resistor does not matter. Check to be sure resistors are placed correctly.

Bend leads out.

Solder each lead. Carefully clip leads when done.

Microprocessor Controlled Counter Kit





When soldering LED's, do not leave the solder iron on pads for more than 5 seconds, or you will destroy the pad.

Place LED's on PC board, <u>flat side of LED's facing right</u>, bend leads out, then solder leads. After soldering, cut leads close to board. There are 12 of these. Hint: Solder only 1 lead of each LED. Place solder iron on soldered lead, melting solder, and then press LED flush to the board. Then solder the other lead.

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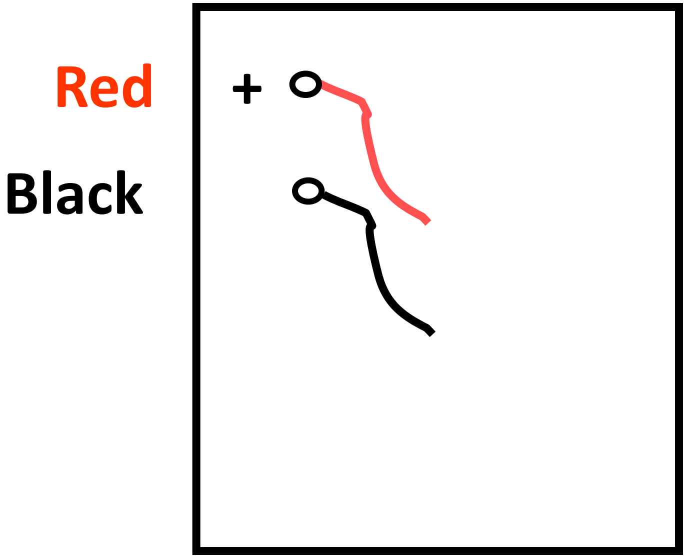

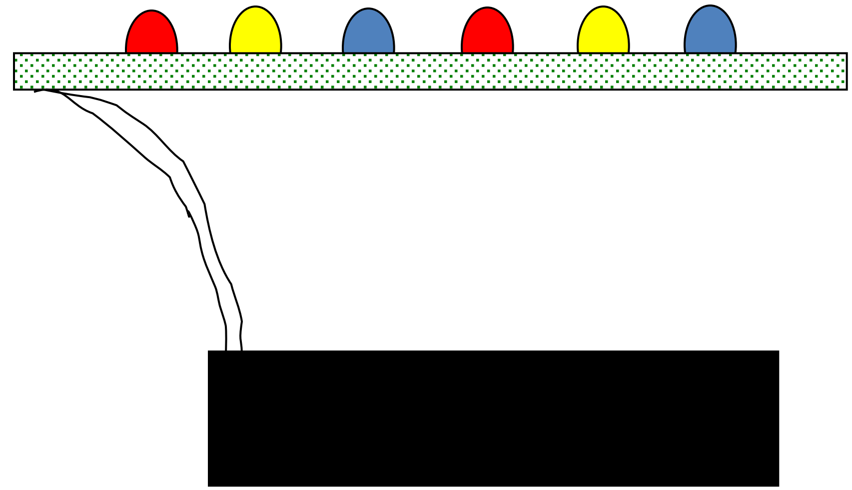

From the bottom of the board, insert the red battery holder lead into the + hole.

Insert the black lead into the other hole. From the top of the board, solder both battery leads.

Inspect board for good solder joints and for no solder shorts.

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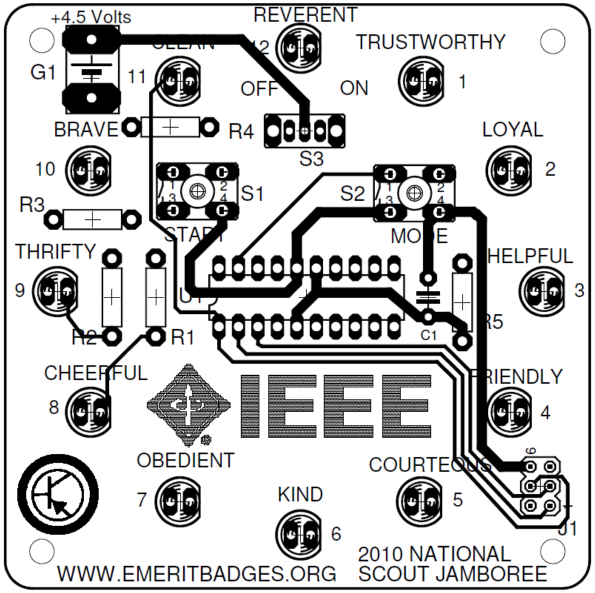

Inspect board for good solder joints and for no solder shorts.
Make sure resistors are in the right place.
Make sure the LEDs are not in backwards.
Insert the batteries into the battery holder. Be sure to get the polarity + and - correct.
Slide **S3** to **ON**.
Push S1 to run.
Push S2 for different program modes.
If the kit does not work, have an instructor help you check it for problems.

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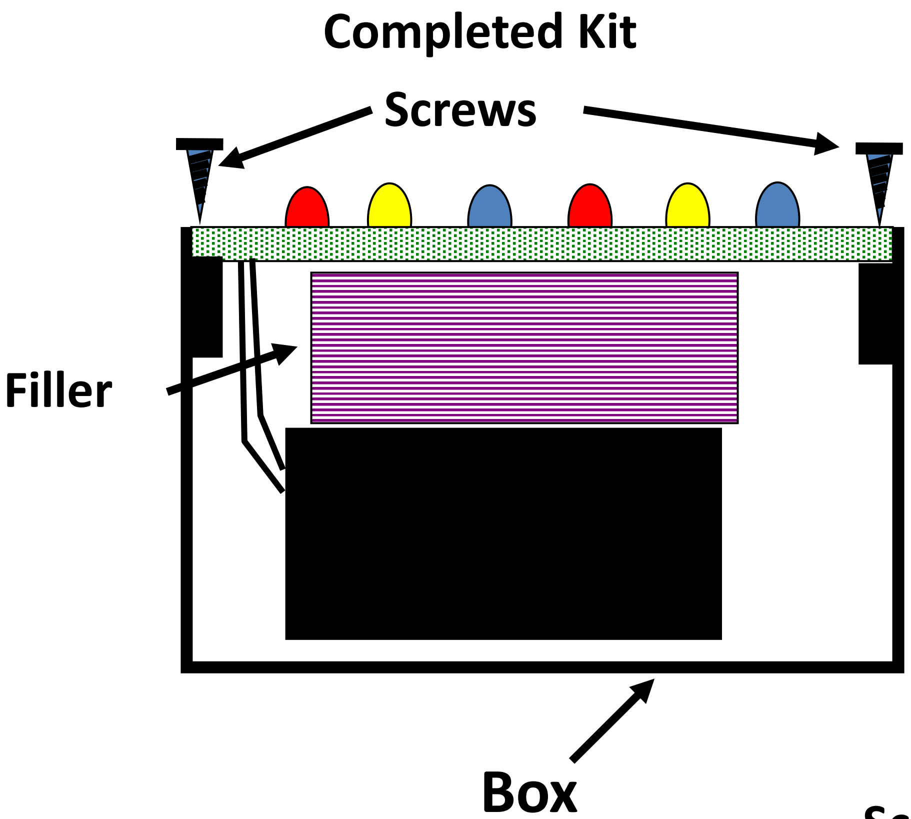

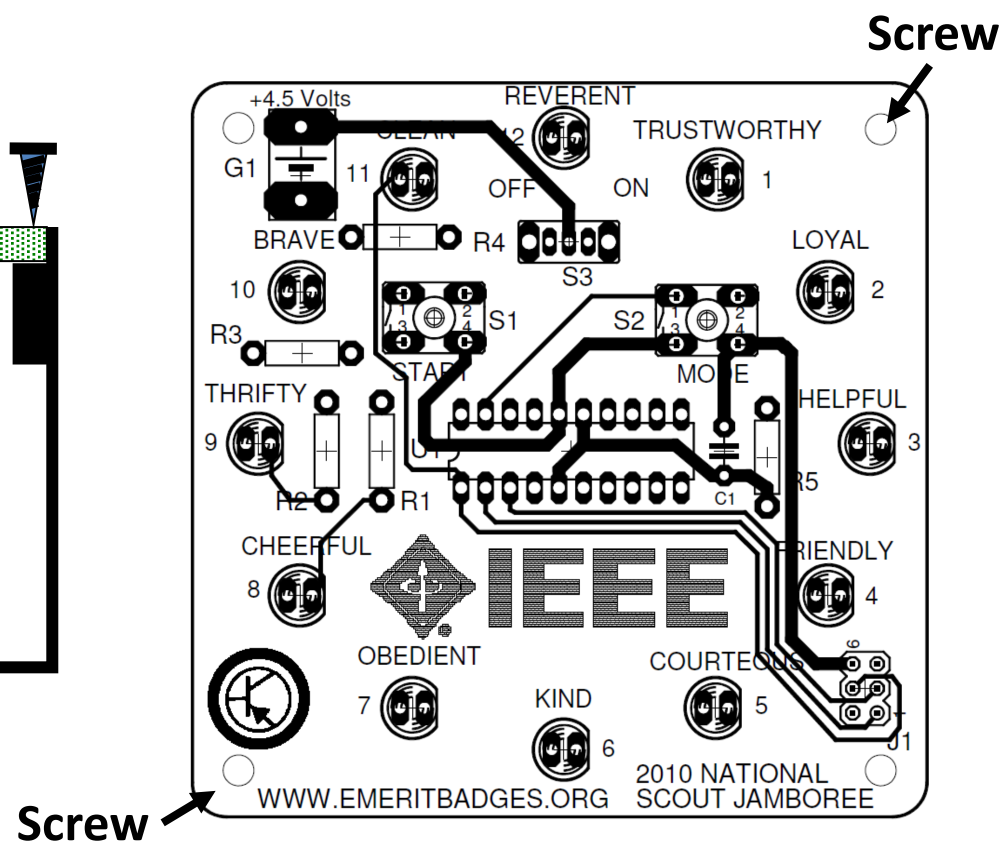

Place the battery holder in the box.
Place foam or wad of paper filler on top of the battery.
Place the board onto the top of the box, and using the 2screws, secure the board to the box. Place the screws in opposite corners.

Careers in Electronics

- Integrated Circuit Design
- Radio Communications Circuits
- Computers
- Satellites / Space
- Computer Networks and Data Communications
- Power Electronics for Vehicles (Hybrid and Electric Cars)
- Military Weapon Systems
- Aerospace and Avionics
- Industrial Controls
- Medical Equipment
- Instrumentation and Sensors
- Test and Measurement
- Component Design
- Vehicle Controls
- Entertainment Electronics
- Cellular Phone Design
- Navigation and Guidance Systems
- Robotics
- Manufacturing – Factory Floor Automation
- Lighting (LED) and display technologies
- Power Distribution Controls – Smart Grid

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Careers in Electronics

- In High School
  - Math Classes - Geometry, Trigonometry, Calculus
  - Science Classes – Chemistry and Physics
  - Tech Ed Classes

- In College - 4 year degree in Electrical Engineering Bachelor of Science (BS) EE
  - Calculus, Differential Equations, Advanced Algebra, Matrices, Transforms
  - Physics, Electromagnetics and Field Theory
  - Chemistry
  - Material Science
  - Thermodynamics / Fluid Mechanics
  - Statics and Dynamics
  - Computer Aided Design
  - Computer Programming
  - Principles of Circuits, Intro to Circuit Design, Digital Design
  - Controls
  - IC Design
  - English / Humanities / Social Study Electives
  - Business and Economics