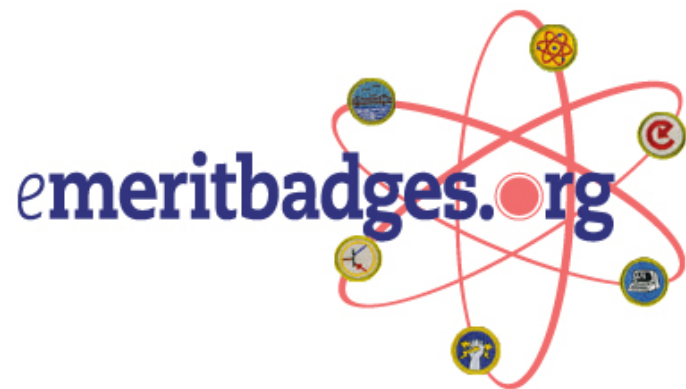


# Electronics Merit Badge

## Class 2



Name \_\_\_\_\_



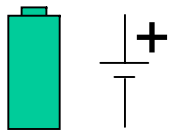
# Electronics Merit Badge

Class 1	AC Power Sources DC Power Sources Voltage, Current and Resistance Build Circuit with Light, Buzzer and Switch
<b>Class 2</b>	<b>Components - Passive and Active</b> <b>Ohms Law</b> <b>Ohms Law Tool Kit</b> <b>Transistor Logic</b> <b>IC Logic</b>
Class 3	Binary Logic Binary / Hex Tool Kit LED Circuit Design
Class 4	Solder Theory Solder Practice Build LED Kit

# Electronic Components

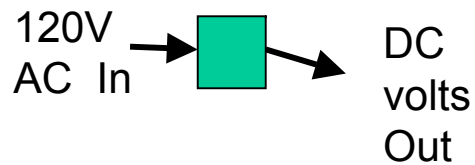
## Batteries

In volts



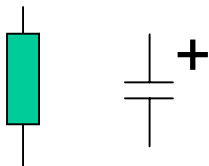
## Power Supply

Outputs Volts



## Capacitors

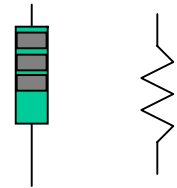
In Farads



2m  
2m

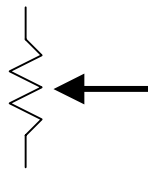
## Resistor

In Ohms



## Potentiometer

Variable Resistor



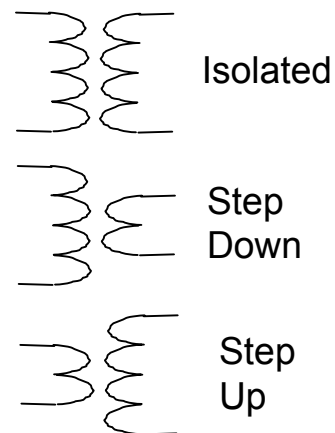
## Inductor or Coil

In henries



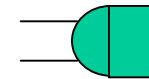
## Transformer

Input voltage



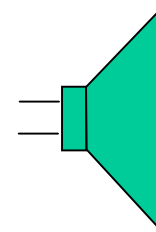
## Microphone

Outputs voltage



## Speaker

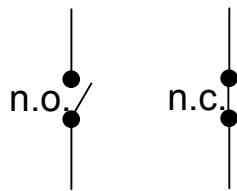
Input voltage



# Electronic Components

## Switch

Normally Open n.o.  
Normally Closed n.c.

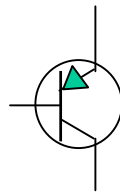


## Slide Switch

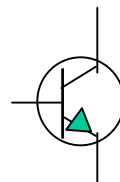


## Transistor

Electronic  
Switch

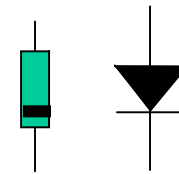


PNP



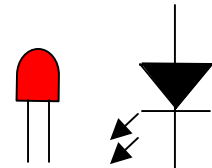
NPN

## Diode



## LED

Light  
Emitting  
Diode



## Meters

Current Meter  
Voltage Meter  
Resistance Meter

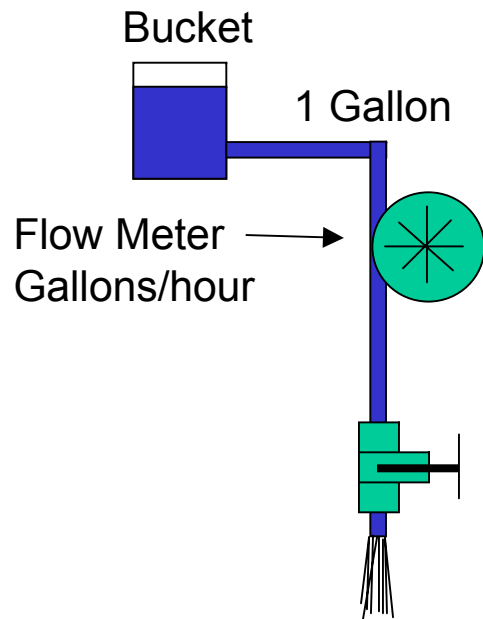


# Electronic Circuit

## Ohms Law

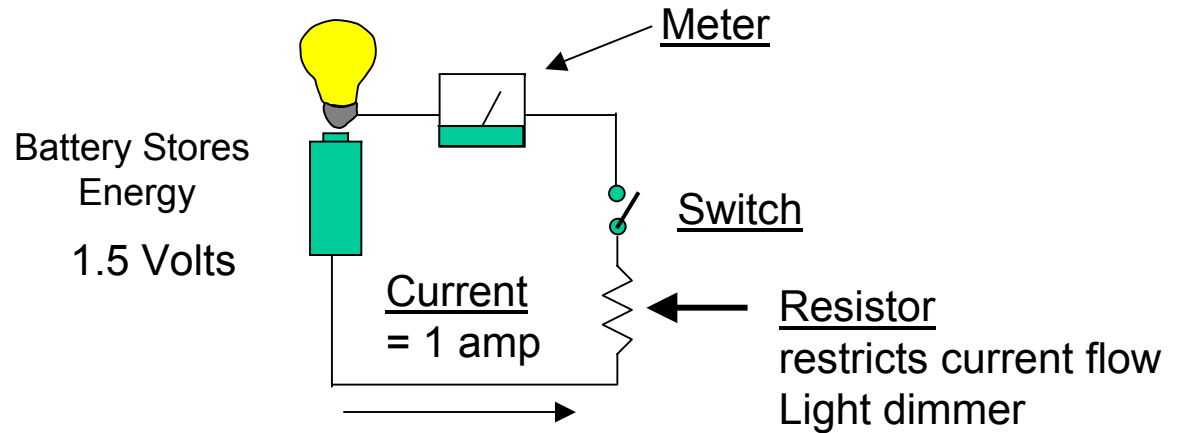
### Water Flow

Bucket Stores Water



Valve restricts water flow

### Current Flow



Voltage measured in volts (Symbol = V)

Current measured in Amps (Symbol = I)

Resistance measured in Ohms (Symbol =  $\Omega$ )

### Formula

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}}$$

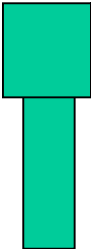
$$\text{Voltage} = \text{Resistance} \times \text{Current}$$

$$\text{Current} = \frac{\text{Voltage}}{\text{Resistance}}$$

# Electronic Components

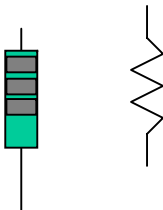
## Resistors

**Pipe**



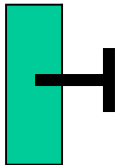
1" Pipe  
1/2" Pipe  
Smaller pipe restricts flow of fluids

**Resistor**

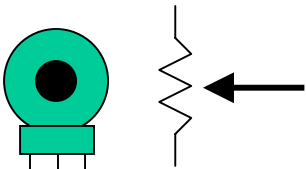


Resistor restricts flow of current.  
Resistors are made of carbon or wire.

**Valve**



Valve restricts flow of fluids



Variable Resistor is a Potentiometer

This could be used to control volume in a radio

**Resistance measured in Ohms (Symbol = Ω)**

2 inch pipe    The smaller the  
1 inch pipe    pipe the more  
3/4 inch pipe    restriction of flow  
1/2 inch pipe  
1/4 inch pipe

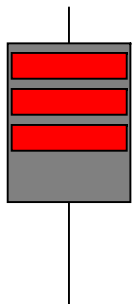
	1 ohm
The larger the resistor value	10 ohm
the more restriction to current flow	100 ohm
	1,000 ohm = 1K ohm
	10,000 ohm = 10 K ohm
	100,000 ohm = 100 K ohm
	1,000,000 ohm = 1 M ohm

# Electronic Components

## Resistors

### Resistor Color Rings

A Resistor Value is determined by its color band and is measured in ohms



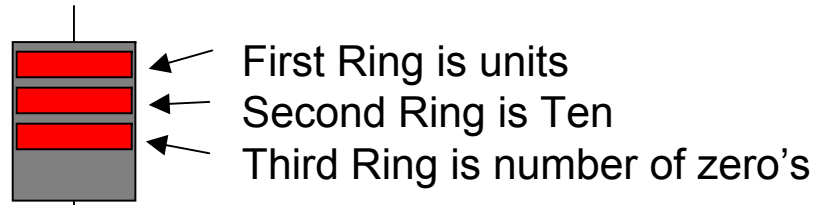
- ← First Ring is units
- ← Second Ring is Ten
- ← Third Ring is number of zero's
- Fourth Ring is tolerance

### Resistor Color Code Values

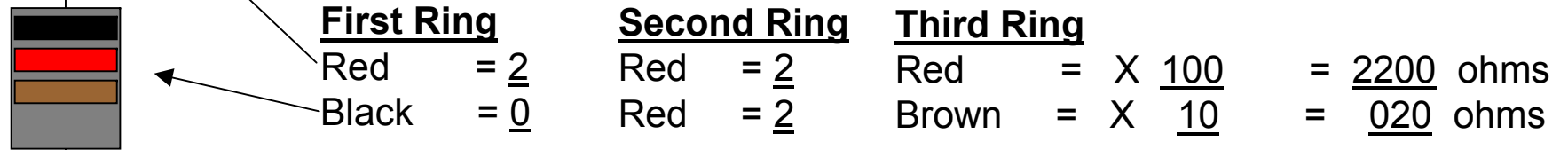
<u>First Ring</u>	<u>Second Ring</u>	<u>Third Ring</u>	<u>Multiplier</u>
Black = 0	Black = 0	Silver = X	.01
Brown = 1	Brown = 1	Gold = X	.1
Red = 2	Red = 2	Black = X	1
Orange = 3	Orange = 3	Brown = X	10
Yellow = 4	Yellow = 4	Red = 2 = X	100
Green = 5	Green = 5	Orange = 3 = X	1000
Blue = 6	Blue = 6	Yellow = 4 = X	10,000
Violet = 7	Violet = 7	Green = 5 = X	100,000
Gray = 8	Gray = 8	Blue = 6 = X	1000,000
White = 9	White = 9	Violet = 7 = X	10,000,000

# Electronic Components

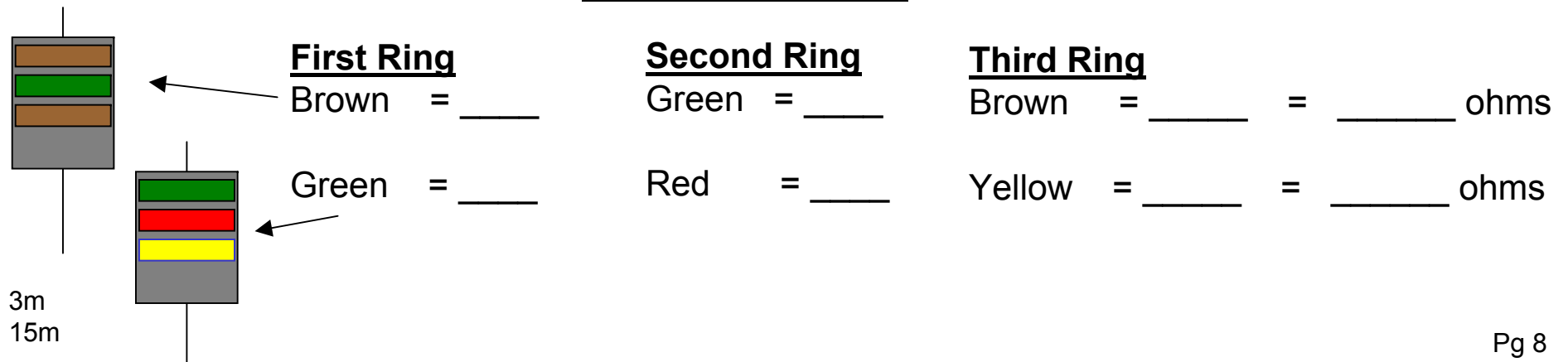
## Resistors



### Example of Color Rings



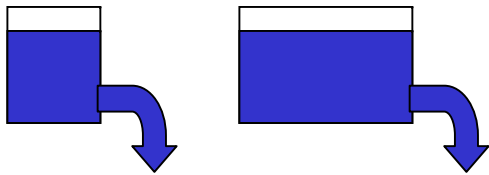
### Test of Color Rings



# Electronic Components

## Voltage Storage Devices

### Bucket



Different size buckets of water with the same height and with a 1/4 inch hole will take different amounts of time to empty

1 gallon = 1 hours

2 gallon = 2 hours

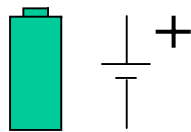
5 gallon = 5 hour

10 gallon = 10 hour

2m  
18m

### Batteries

Sold already charged. Some may be recharged



Most batteries are  
1.5 Volts per cell.

AAA = .2 amp hours

AA = .5 amp hours

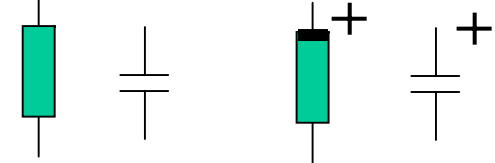
C = 1 amp hour

D = 4 amp hour

### Capacitors

Stores small amounts  
of Voltage charge

Measured in farads



Un-Polarized

Polarized

1 f = 1.0 farad

10 mf = .01 Farad

1,000uf = .001 Farad

100uf = .0001 Farad

10uf = .00001Farad

1 uf = .000001Farad

.1 uf = .0000001

.01 uf = .00000001

.001 uf = .000000001

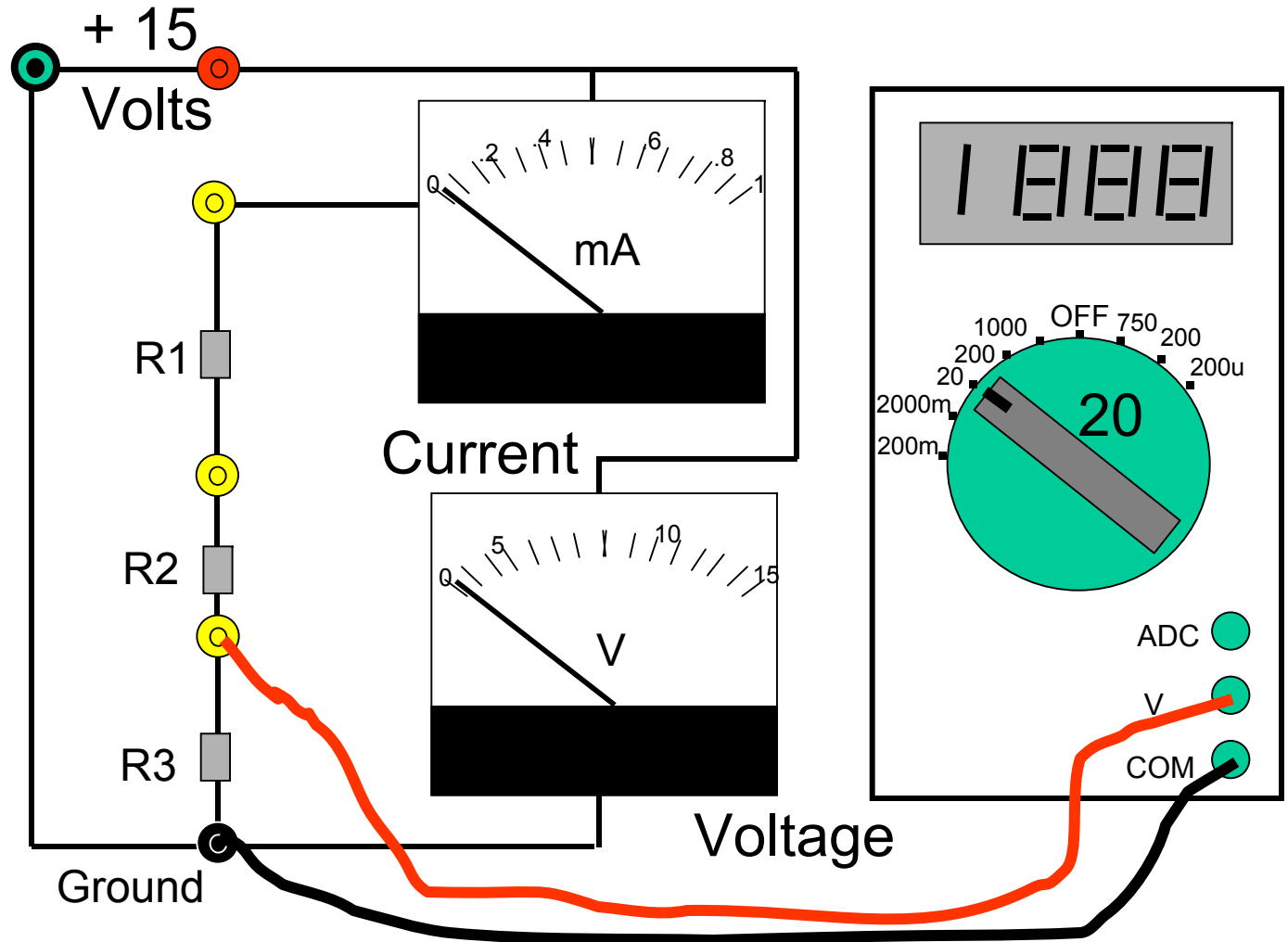
100 pf = .0000000001

10 pf = .00000000001

1 pf = .000000000001

# Resistor Box

Measure Voltage across resistor R3 and Calculate resistor value.  
  
Use current indicated on current meter



$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}} = \frac{\text{_____}}{\text{ma} = .001} = \text{_____ ohms}$$

10m  
28m

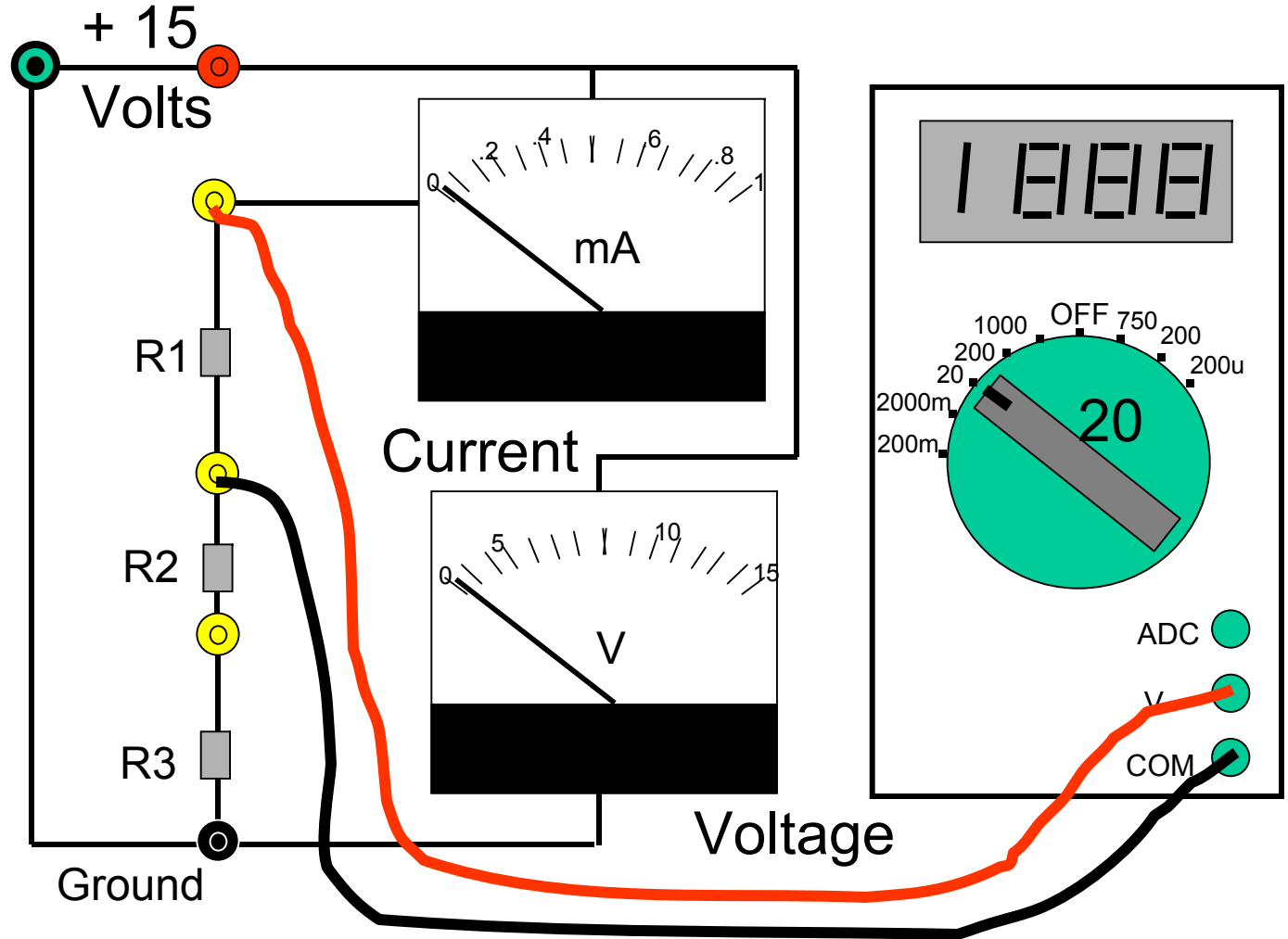
Look at Color Rings of R3 \_\_\_\_\_ = \_\_\_\_\_

Instructor \_\_\_\_\_

# Resistor Box

Measure Voltage across resistor R1 and Calculate resistor value.

Use current indicated on current meter



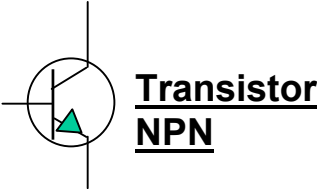
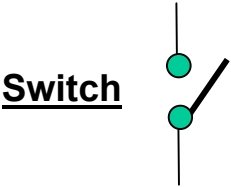
$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}} = \frac{\text{_____}}{\text{_____ ma} = .001} = \text{_____ ohms}$$

10m 38m Look at Color Rings of R1 \_\_\_\_\_ = \_\_\_\_\_

Instructor \_\_\_\_\_

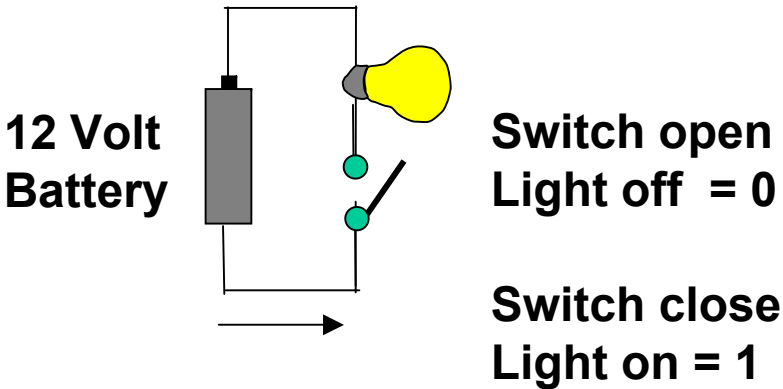
# Transistors

## A Transistor is an Electronic Switch

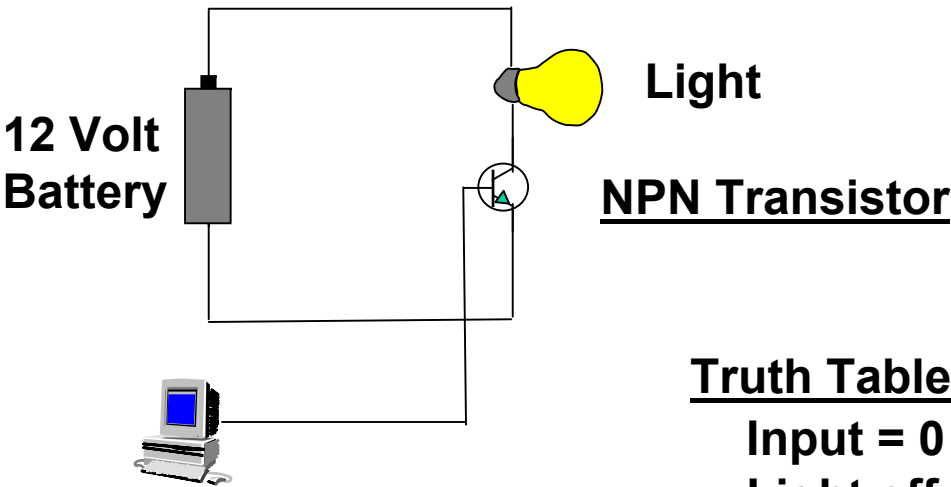


Transistor come in  
Different sizes depending  
On the amount of current  
And voltage is required

### Mechanical Switch Circuit



### Transistor Switch Circuit



### Truth Table

Input = 0  
Light off

Input = 1  
Light on

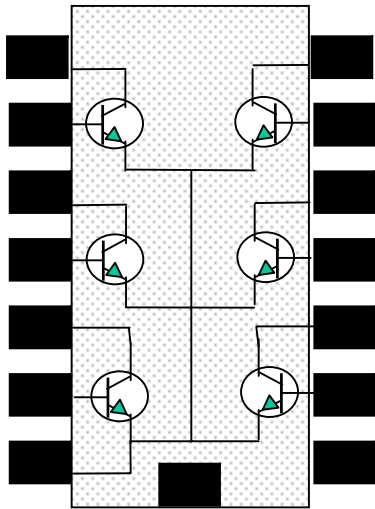
Computer can  
send a signal to turn  
on the transistor which  
then turns on the light

# Electronic Components

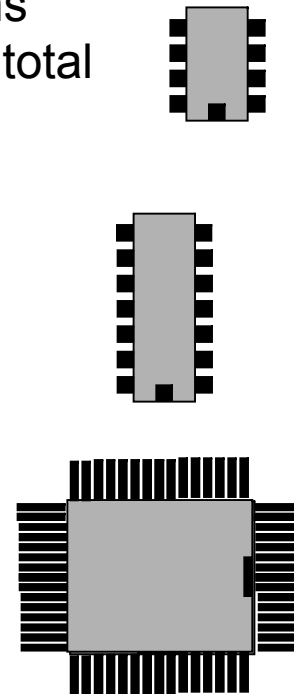
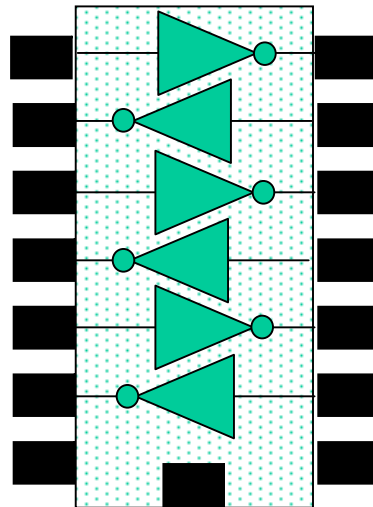
## IC Integrated Circuits

An integrated circuit (IC) consists of multiple transistors. The number of transistors can vary from just a few (circuits shown below), to several million that are in a (Pentium microprocessor).

6 Transistors in one IC



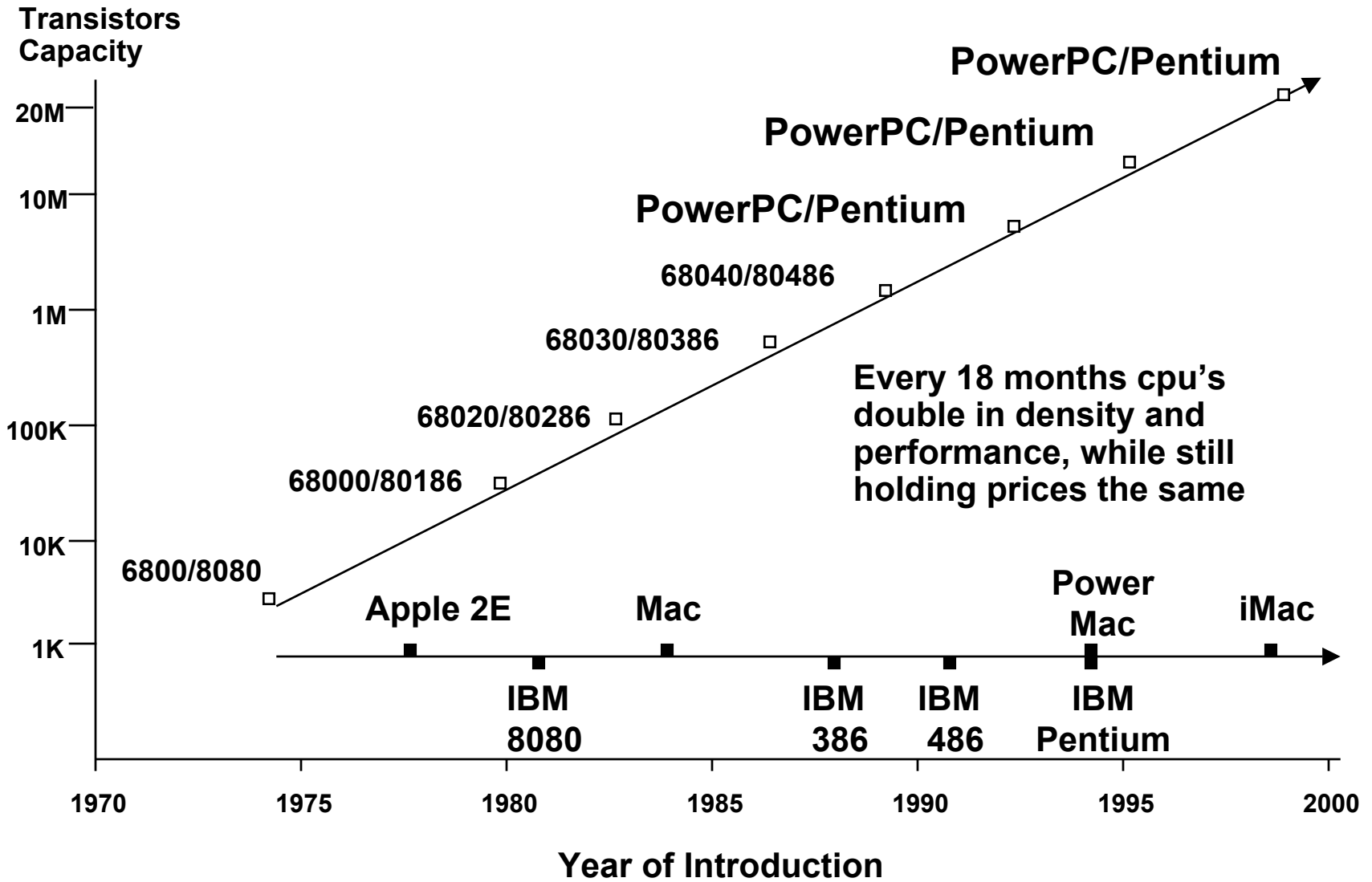
This IC has 6 inverters  
An inverter contains  
6 Transistors = 36 total



### Functions

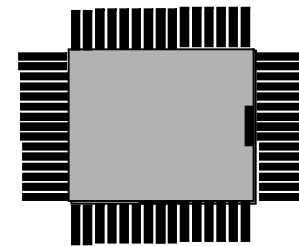
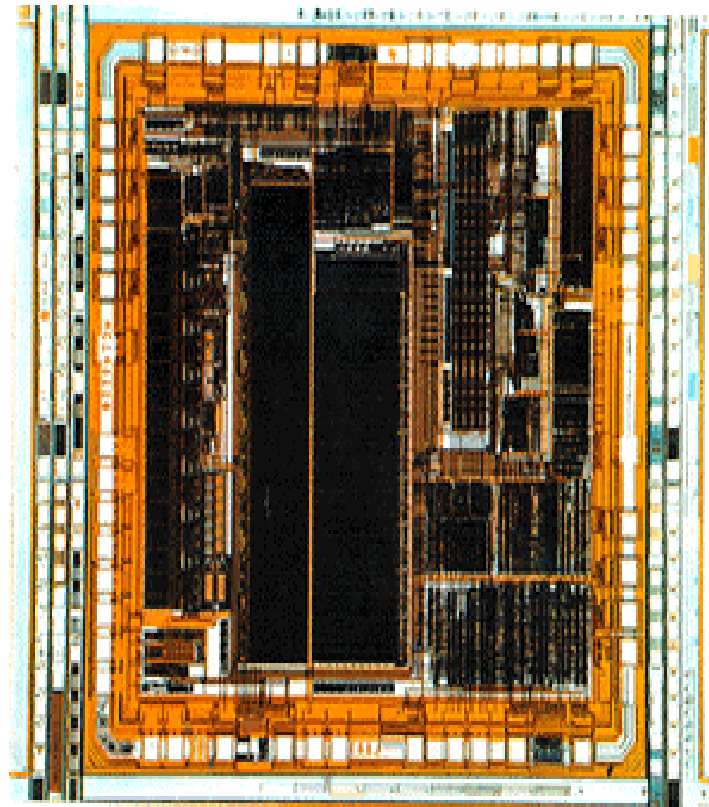
- Inverters
- Gates
- Flip flops
- Counters
- Memory
- MPU
- Watch IC's
- Calculators IC's
- Microwave Timer IC's
- Radio IC's
- Dialer IC's
- Car Controller IC's

# Microprocessor Road Map



# Microprocessor Integrated Circuit

60,000 Transistors



1m  
43m