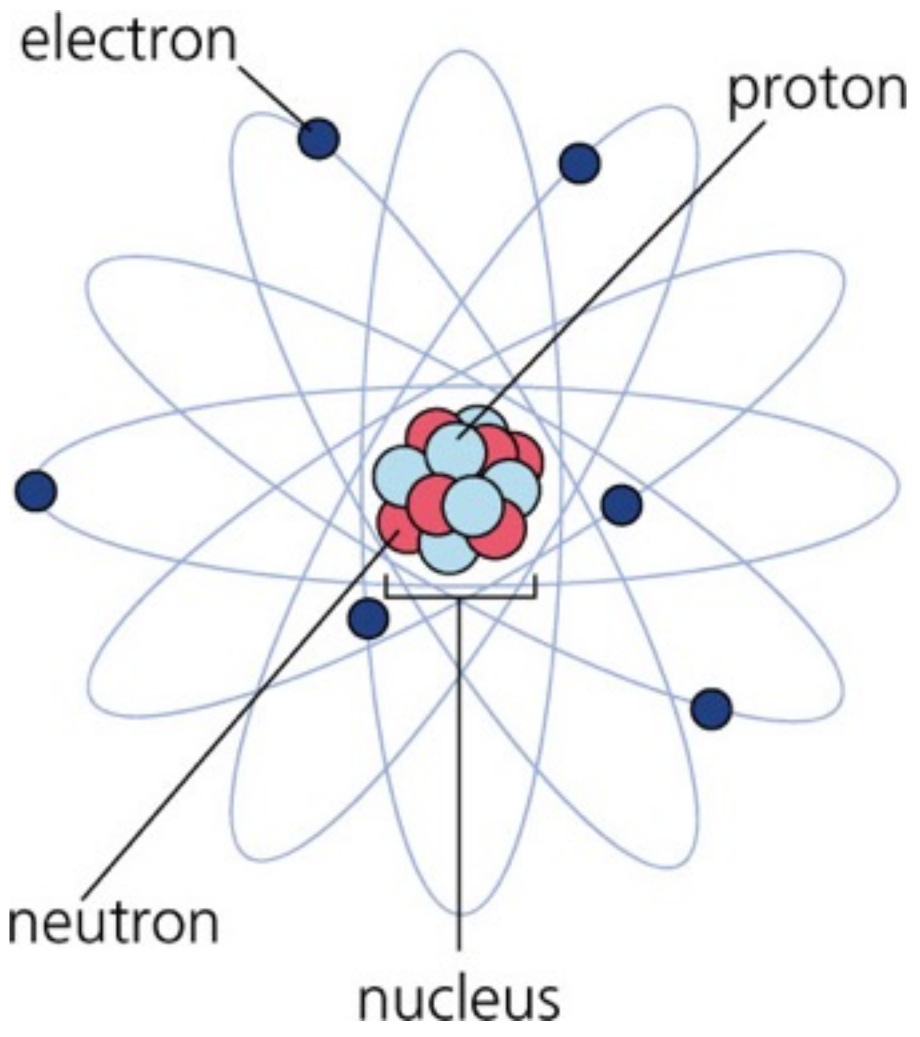
WELCOME TO
THE DUCK TAPE FILES

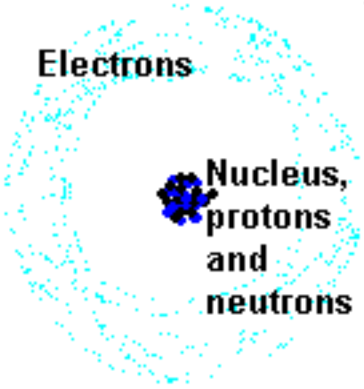
FAILURE IS **LEARNING**

It’s all about balancing the **electrons….**

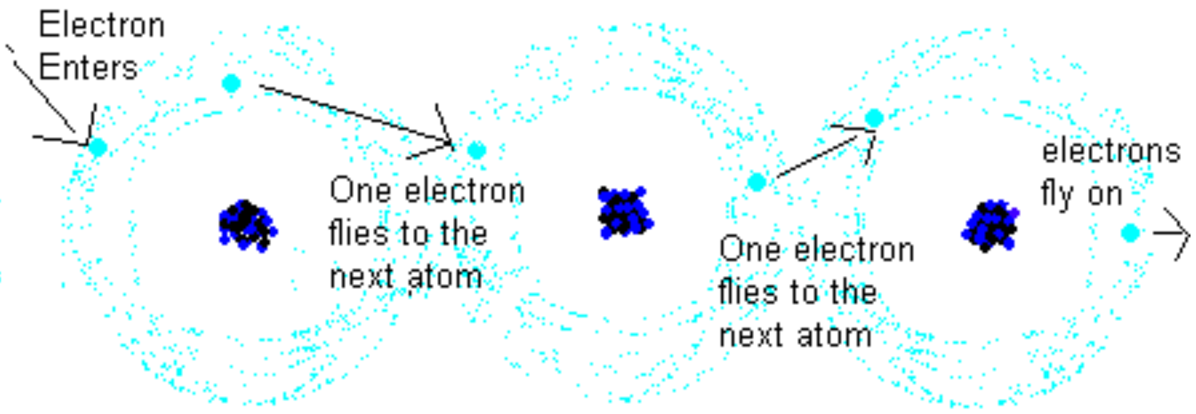


Nature likes

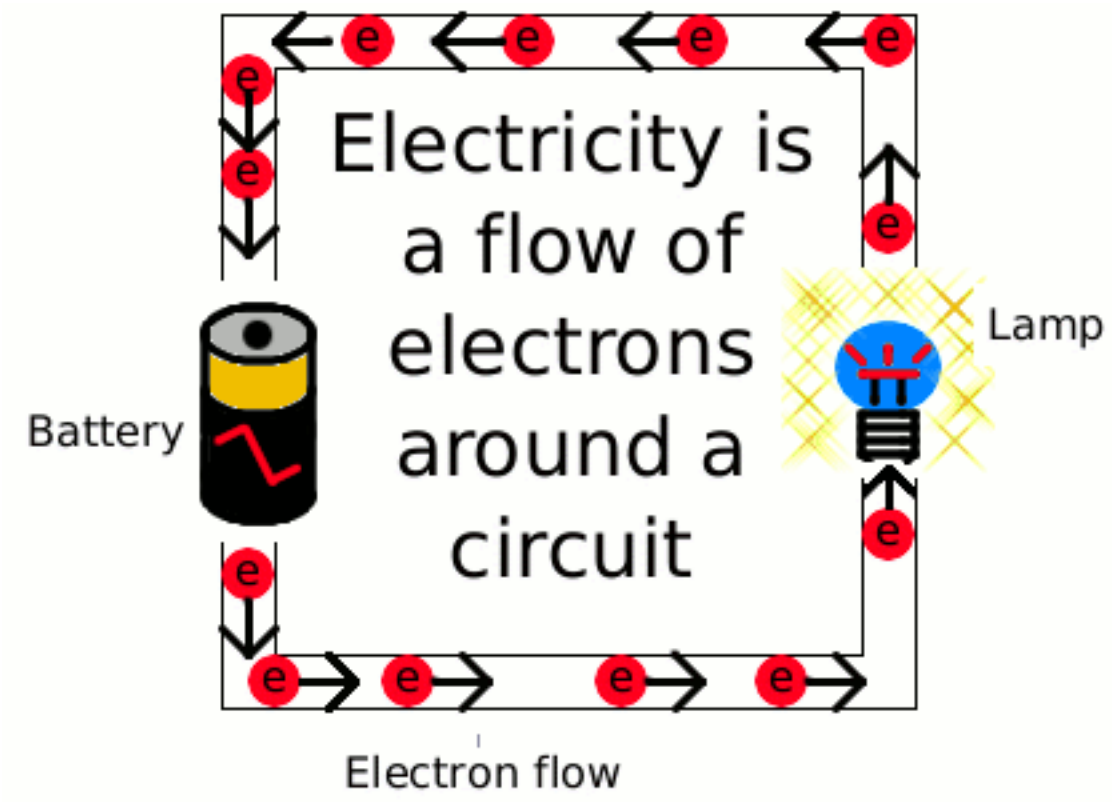
balance



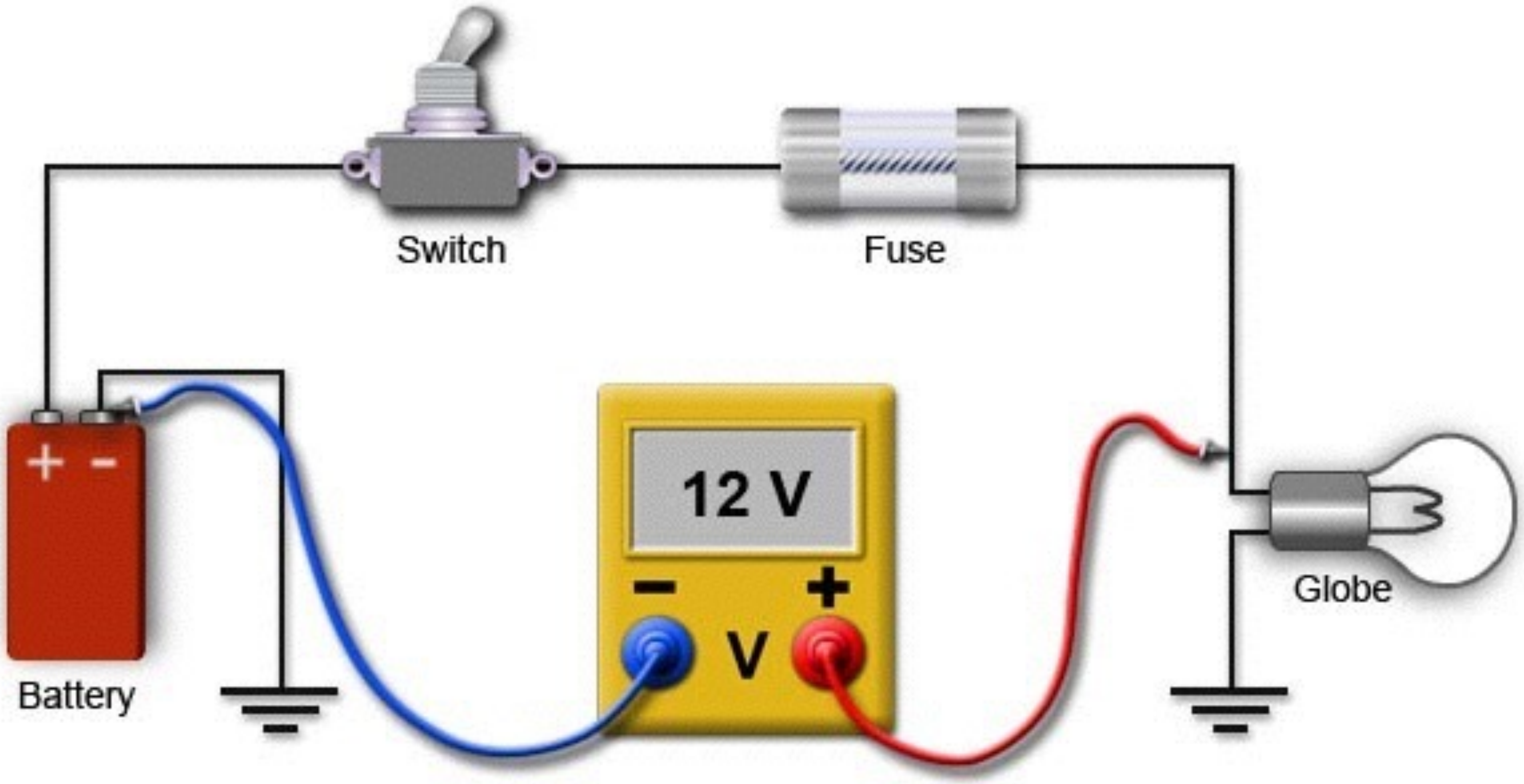
An Atom


Electron Enters
One electron flies to the next atom
One electron flies to the next atom
electrons fly on

Flow of Electricity



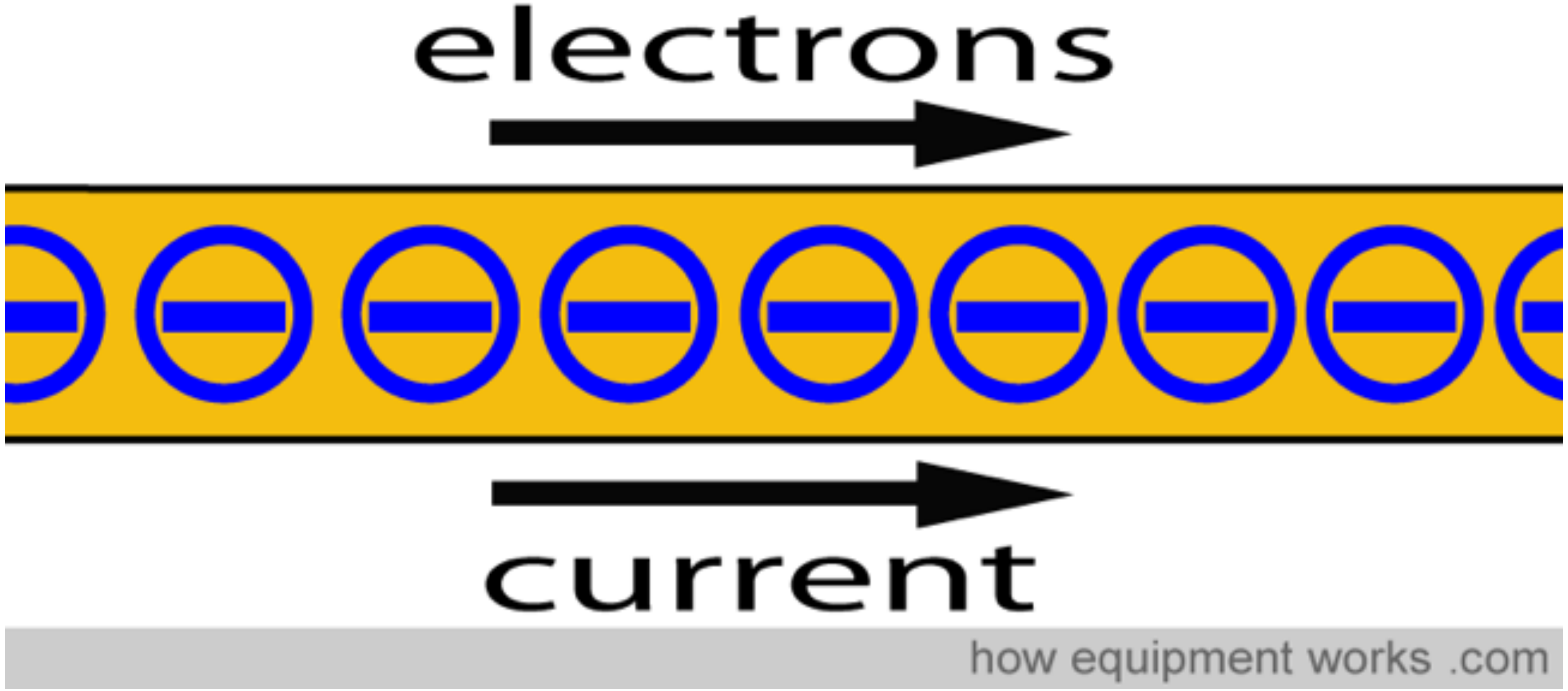
Electricity is a flow of electrons around a circuit



Voltage (V)

also a volt or an EMF or as potential difference . It gets used up as it goes around the circuit. Think of it like your energy if you’re running a race.

1. What’s an electron?
2. What’s Arduino?
3. What’s electricity?

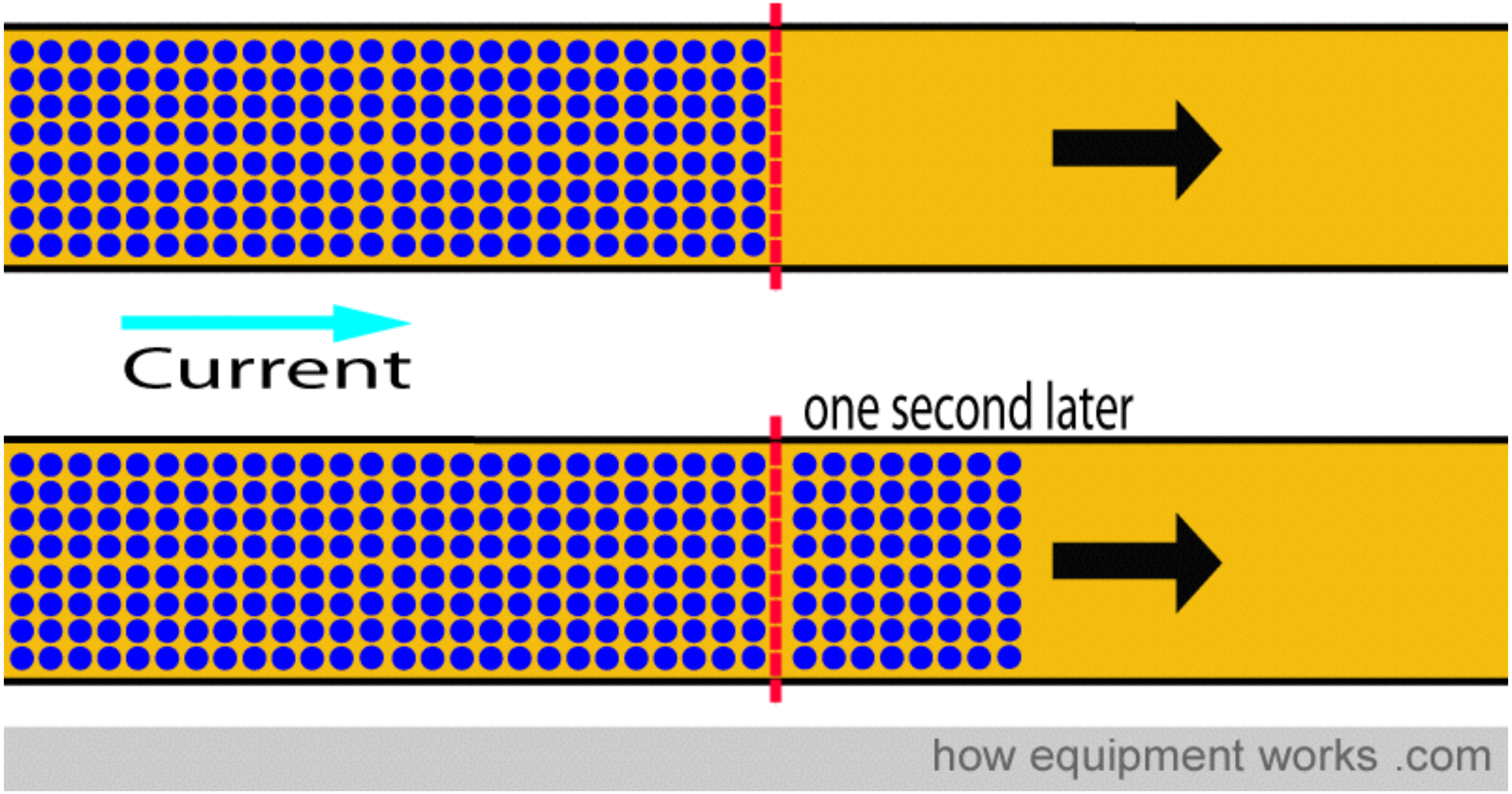


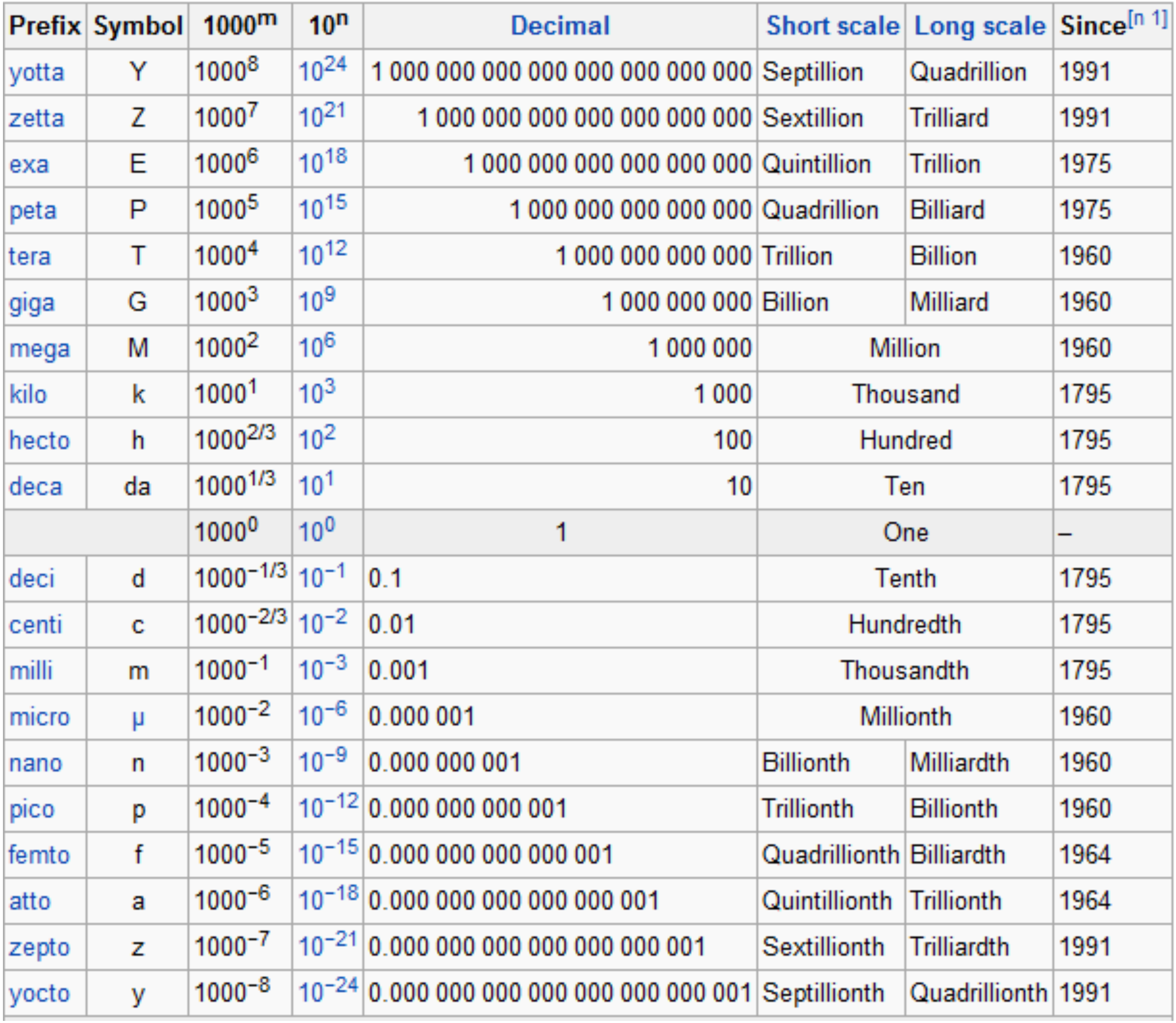
Current (I)

Electrons can be thought of as negatively charged "particles". The movement of these electrons is called current.

Amperes (Amps)

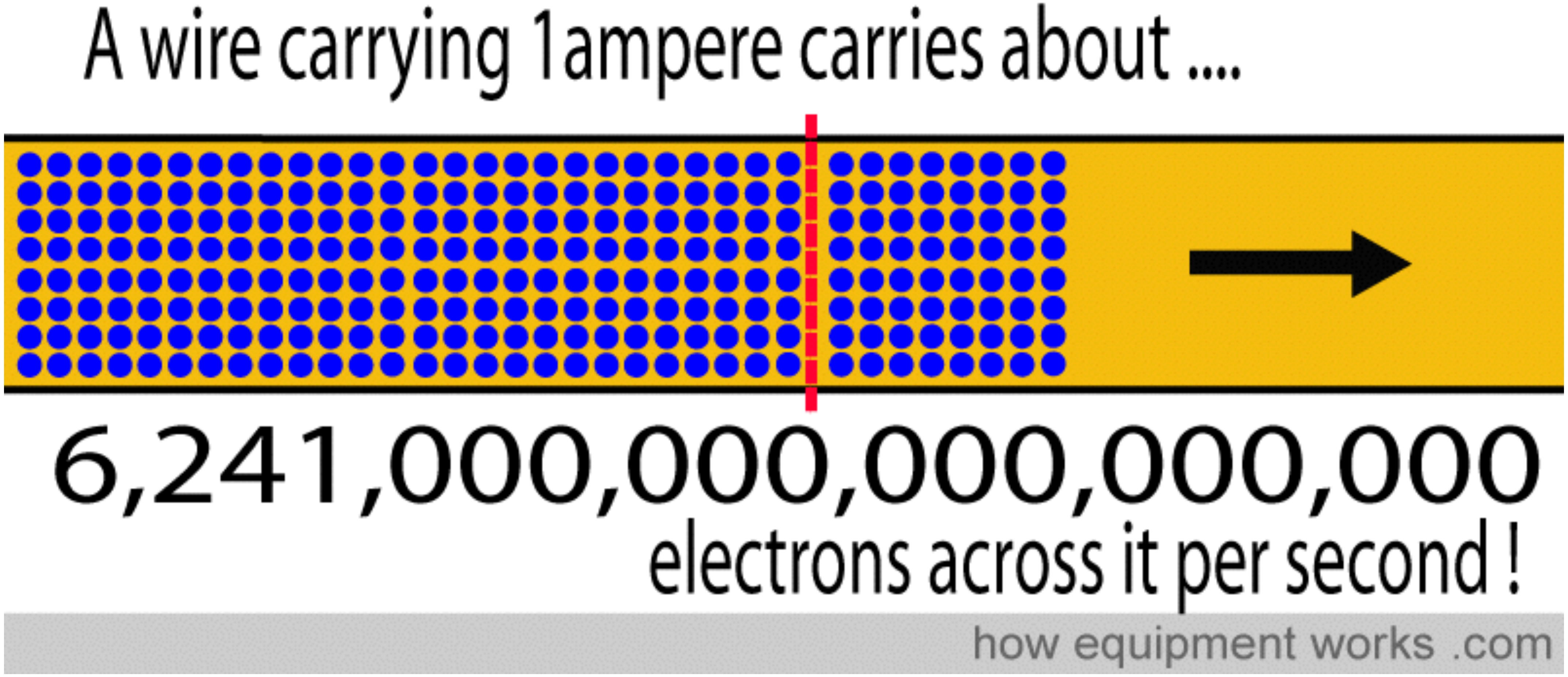
Current is measured in units called ‘amperes’. The number of amperes in a wire relates to how many electrons pass a cross section of the wire per second.





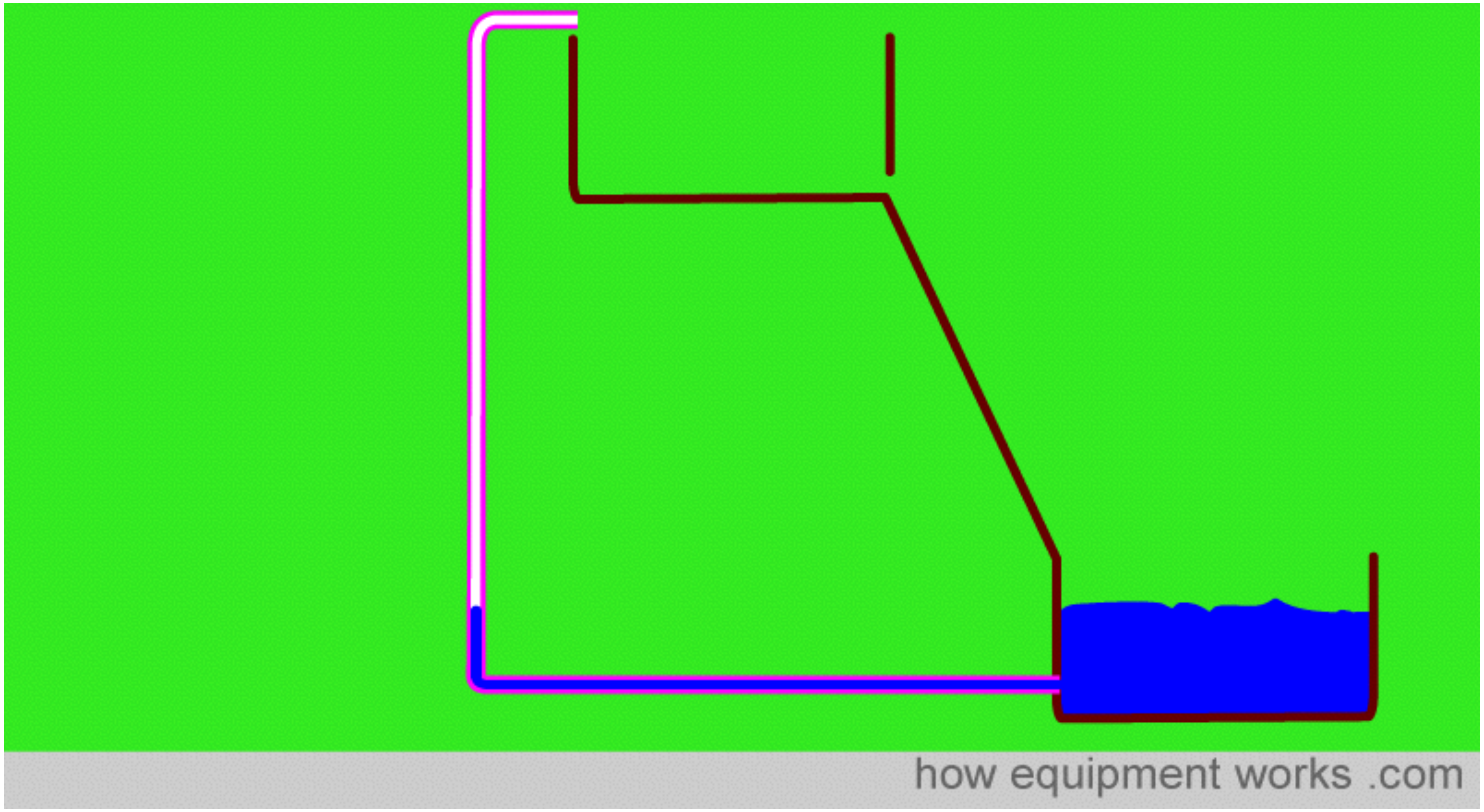
Prefix	Symbol	1000^m	10^n	Decimal	Short scale	Long scale	Since[n 1]
yotta	Y	1000^8	10^{24}	1 000 000 000 000 000 000 000 000	Septillion	Quadrillion	1991
zetta	Z	1000^7	10^{21}	1 000 000 000 000 000 000 000	Sextillion	Trilliard	1991
exa	E	1000^6	10^{18}	1 000 000 000 000 000 000	Quintillion	Trillion	1975
peta	P	1000^5	10^{15}	1 000 000 000 000 000	Quadrillion	Billiard	1975
tera	T	1000^4	10^{12}	1 000 000 000 000	Trillion	Billion	1960
giga	G	1000^3	10^9	1 000 000 000	Billion	Milliard	1960
mega	M	1000^2	10^6	1 000 000	Million		1960
kilo	k	1000^1	10^3	1 000	Thousand		1795
hecto	h	$1000^{2/3}$	10^2	100	Hundred		1795
deca	da	$1000^{1/3}$	10^1	10	Ten		1795
		1000^0	10^0	1	One		–
deci	d	$1000^{-1/3}$	10^{-1}	0.1	Tenth		1795
centi	c	$1000^{-2/3}$	10^{-2}	0.01	Hundredth		1795
milli	m	1000^{-1}	10^{-3}	0.001	Thousandth		1795
micro	µ	1000^{-2}	10^{-6}	0.000 001	Millionth		1960
nano	n	1000^{-3}	10^{-9}	0.000 000 001	Billionth	Milliardth	1960
pico	p	1000^{-4}	10^{-12}	0.000 000 000 001	Trillionth	Billionth	1960
femto	f	1000^{-5}	10^{-15}	0.000 000 000 000 001	Quadrillionth	Billiardth	1964
atto	a	1000^{-6}	10^{-18}	0.000 000 000 000 000 001	Quintillionth	Trillionth	1964
zepto	z	1000^{-7}	10^{-21}	0.000 000 000 000 000 000 001	Sextillionth	Trilliardth	1991
yocto	y	1000^{-8}	10^{-24}	0.000 000 000 000 000 000 000 001	Septillionth	Quadrillionth	1991

A current of one ampere relates to a certain number of electrons passing a cross section of the wire in one second. This number is absolutely huge, and please don’t bother to remember it. The wire below is carrying one ampere of current.


A wire carrying 1ampere carries about ....
6,241,000,000,000,000,000
electrons across it per second !
how equipment works .com

1. What’s V?
2. What’s I?
3. What’s an R?

It’s convention to refer to current as flowing downhill even though the electrons are going from negative to positive. Why? Because metaphor.



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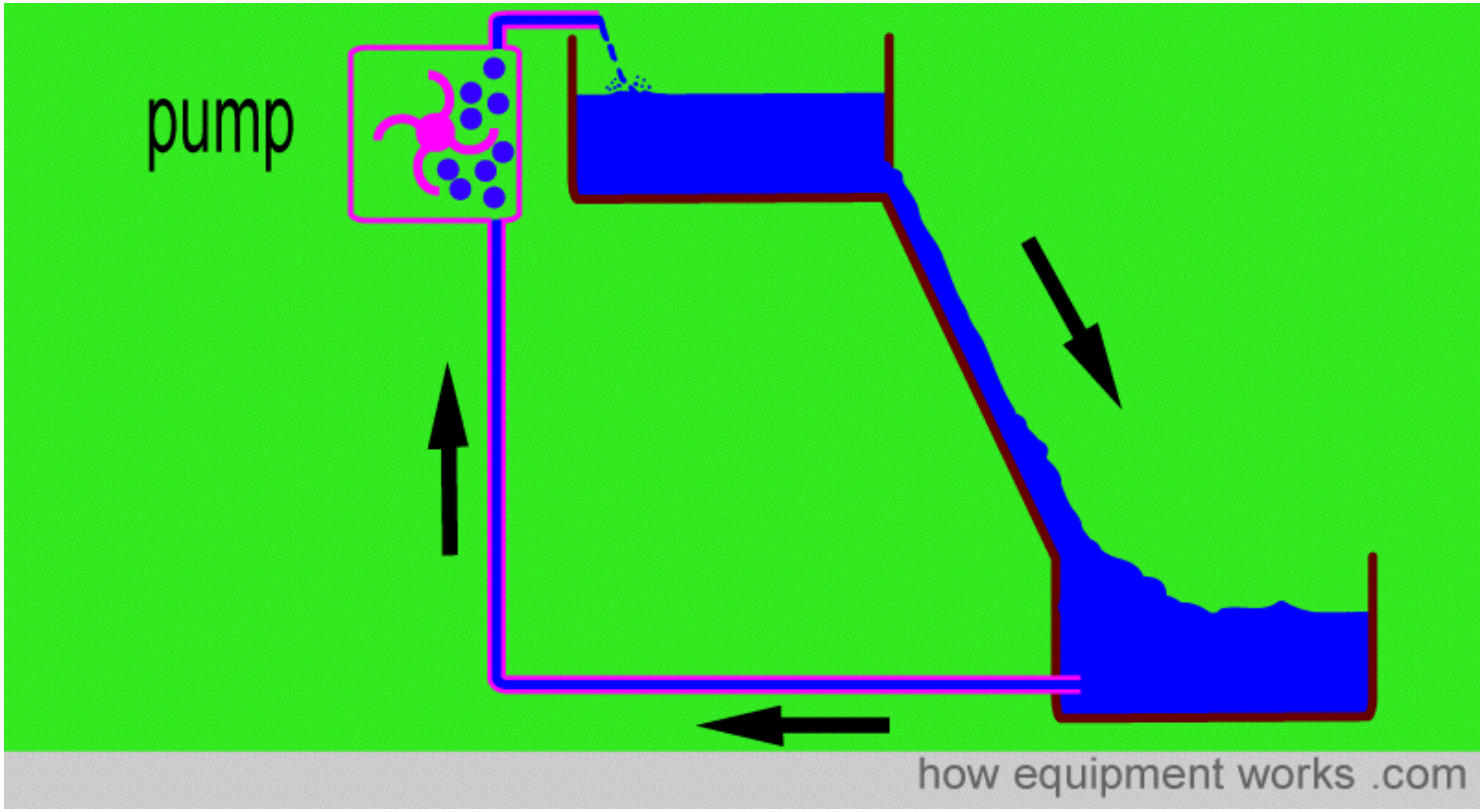
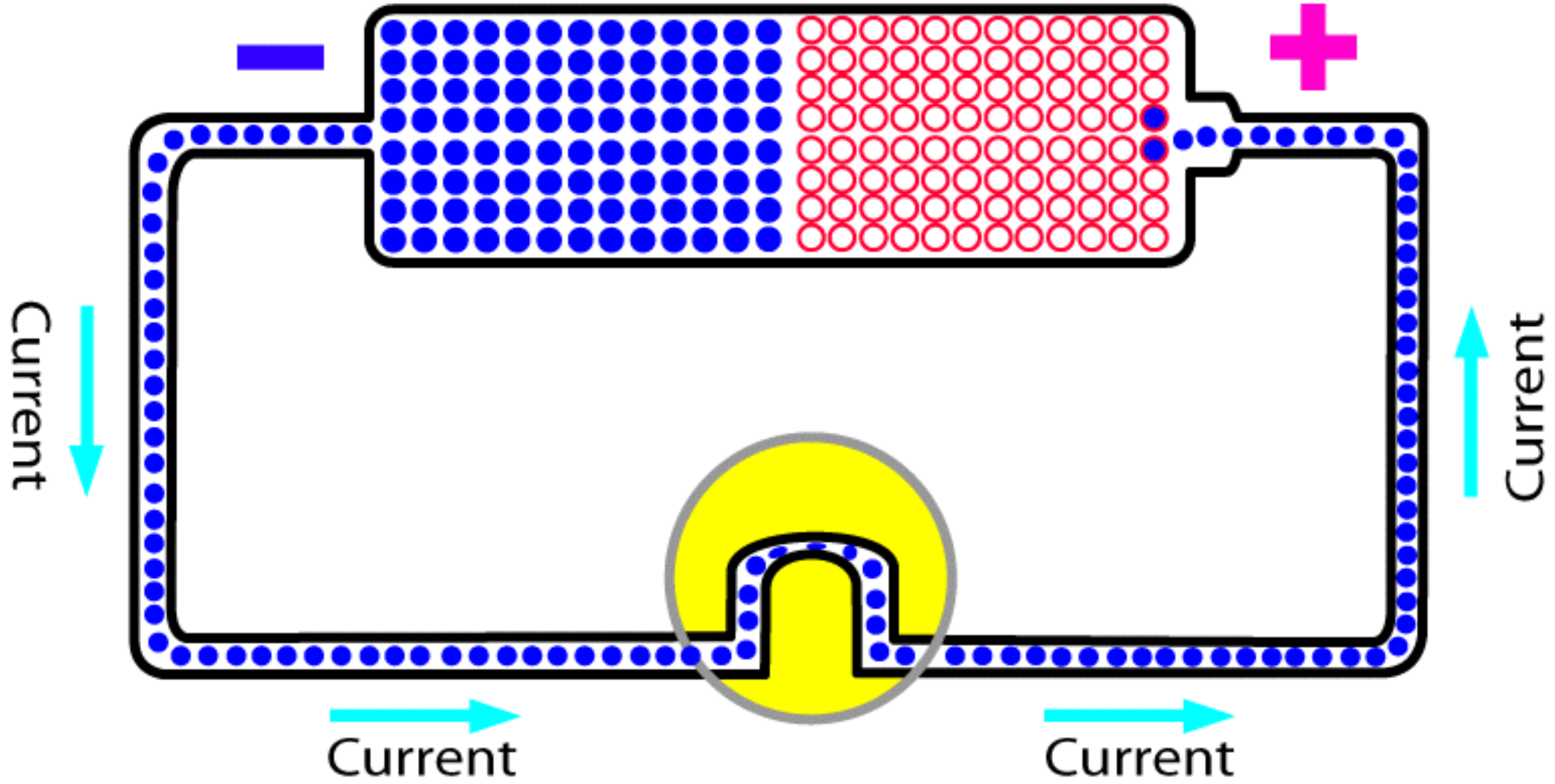
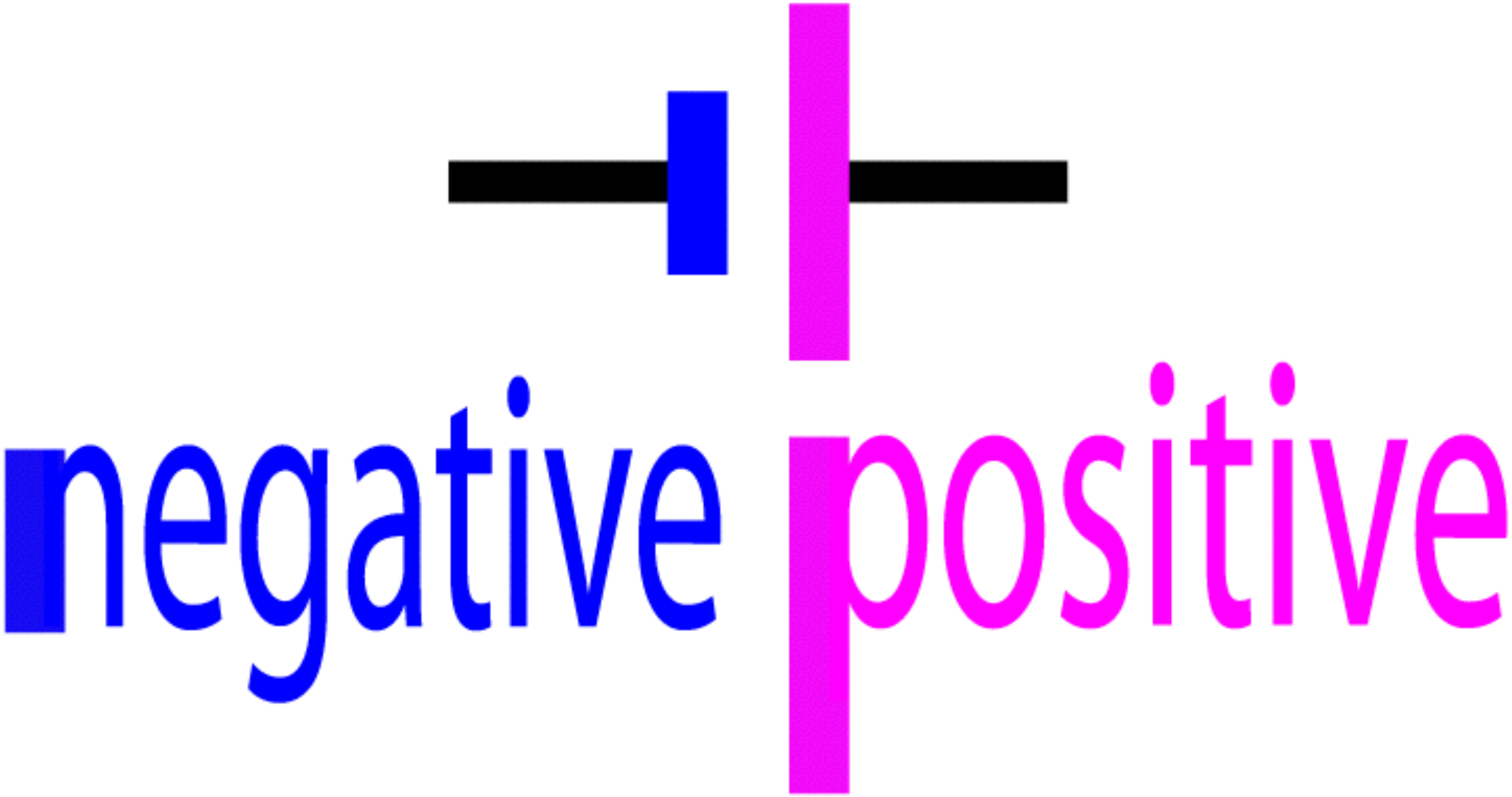
What’s a circuit?

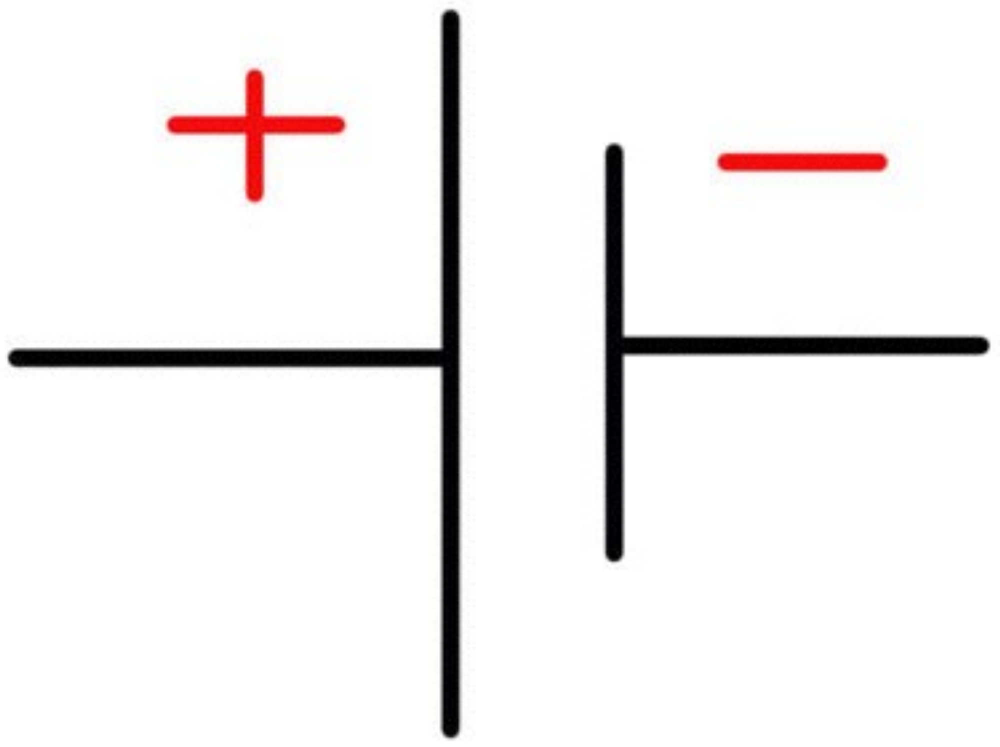

pump
how equipment works .com



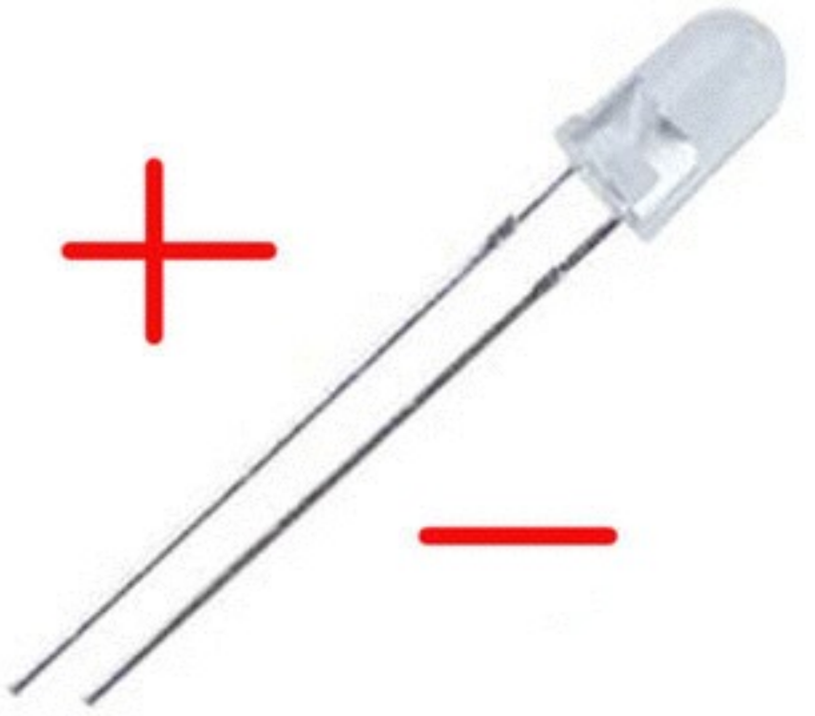
how equipment works .com



negative positive



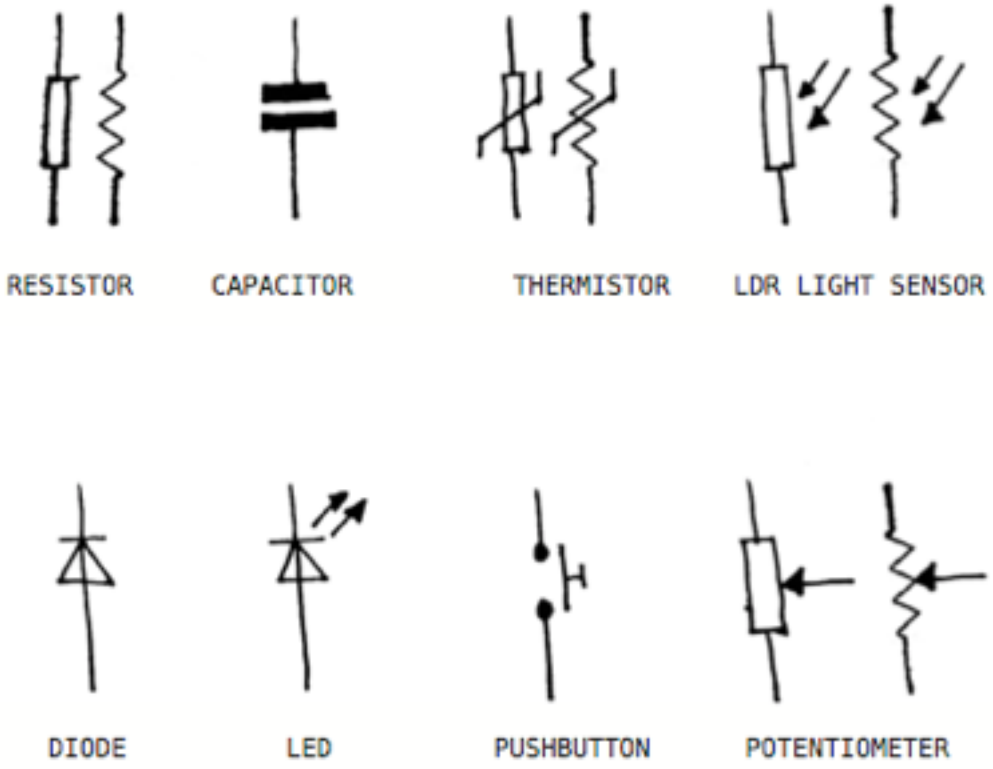
BATTERY



longer lead is postive.

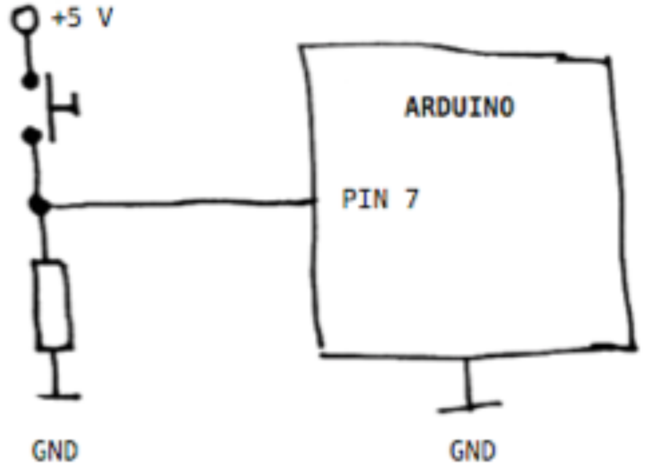
http://www.instructables.com/id/HOW-TO-READ-CIRCUIT-DIAGRAMS/

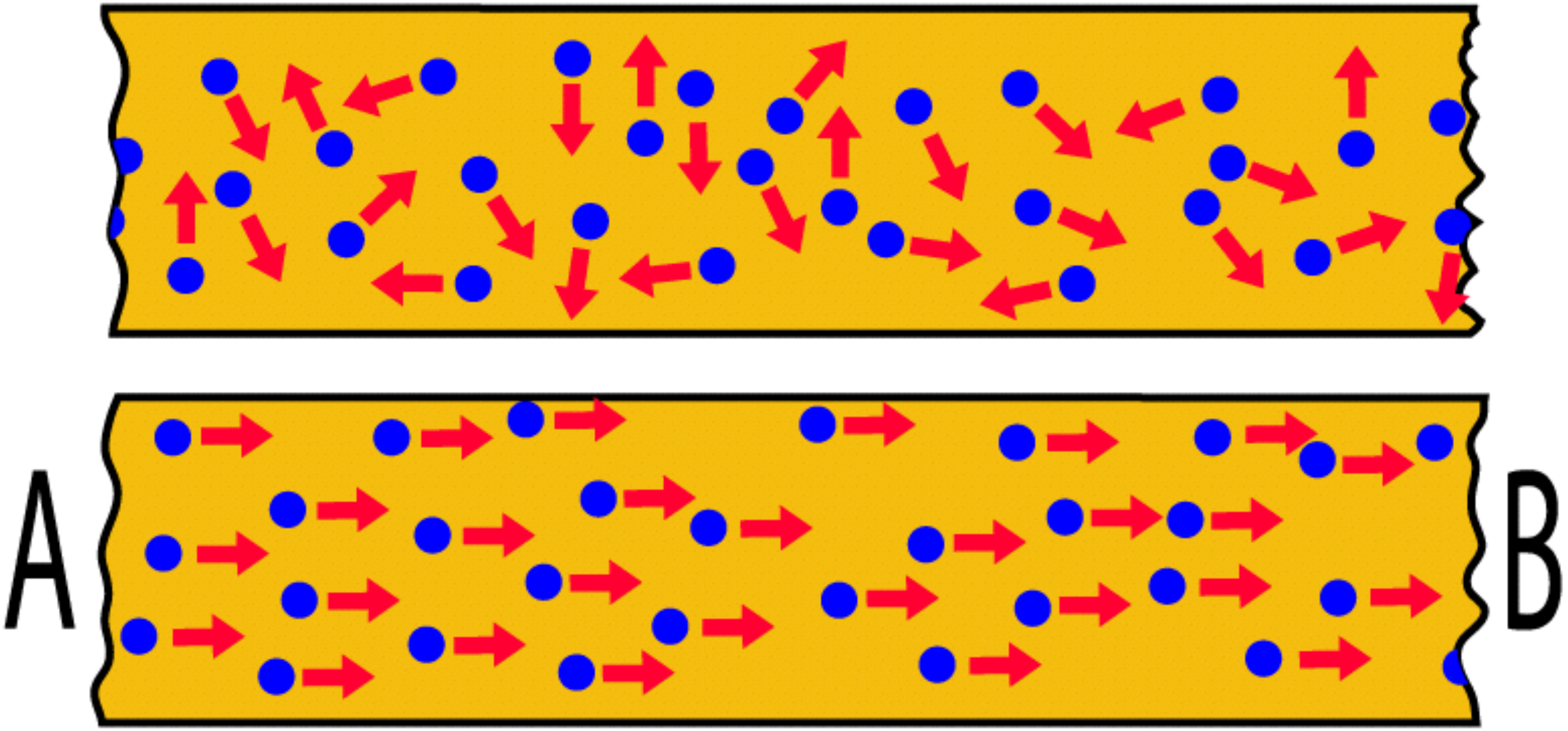
This is all you need to understand basic schematics. Here is a more comprehensive list of symbols and their meanings:

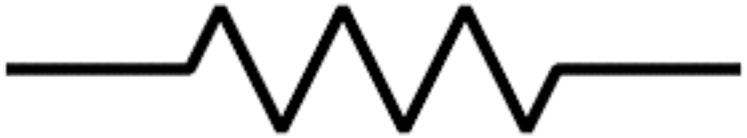


You may encounter variations in these symbols (for example, both variants of resistor symbols are shown here). See en.wikipedia.org/wiki/Electronic_symbol for a larger list of electronics symbols. By convention, diagrams are drawn from left to right. For example, a radio would be drawn starting with the antenna on the left, following the path of the radio signal as it makes its way to the speaker (which is drawn on the right).

The following schematic describes the push-button circuit shown earlier in this book:

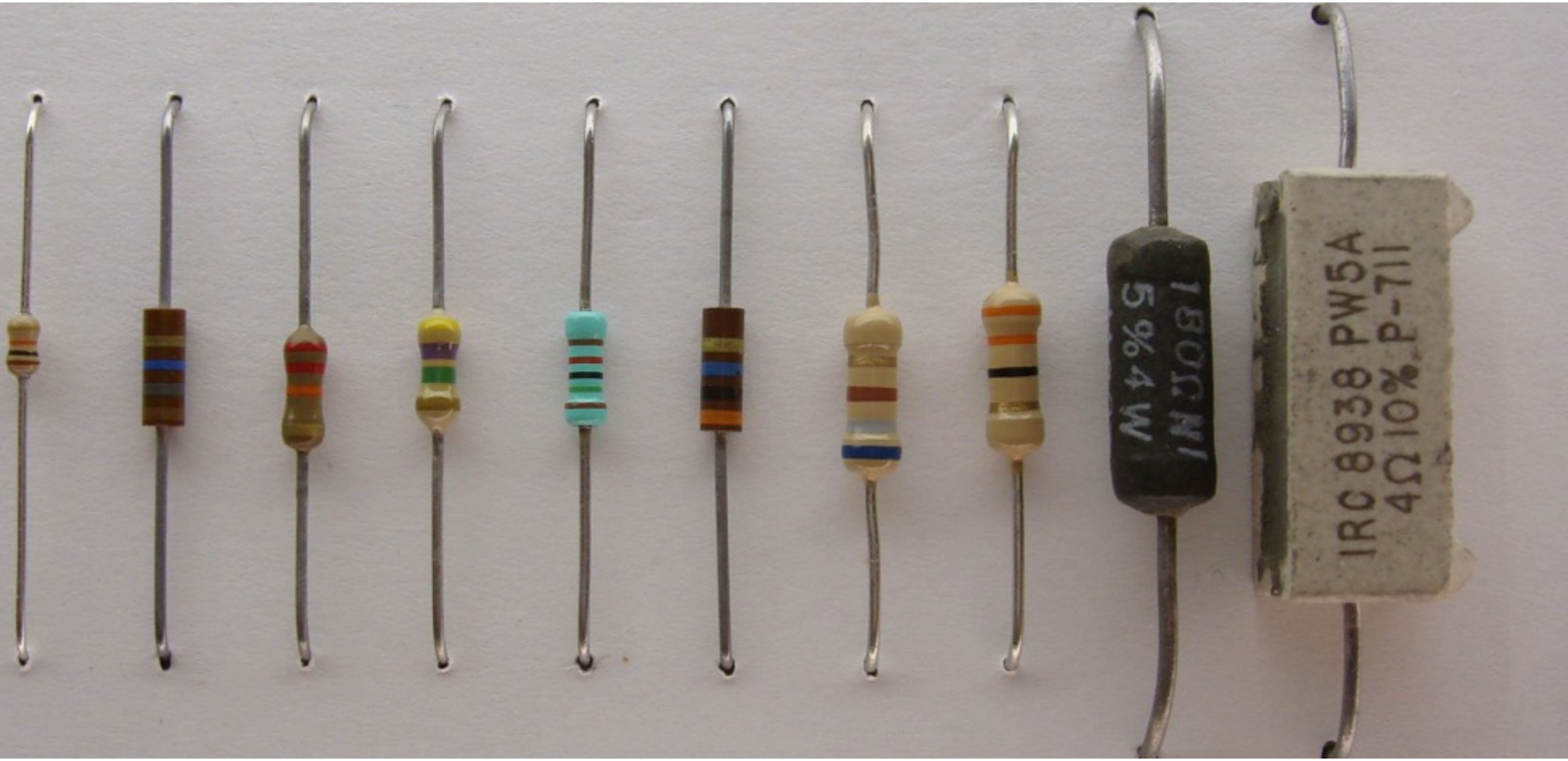



A
B

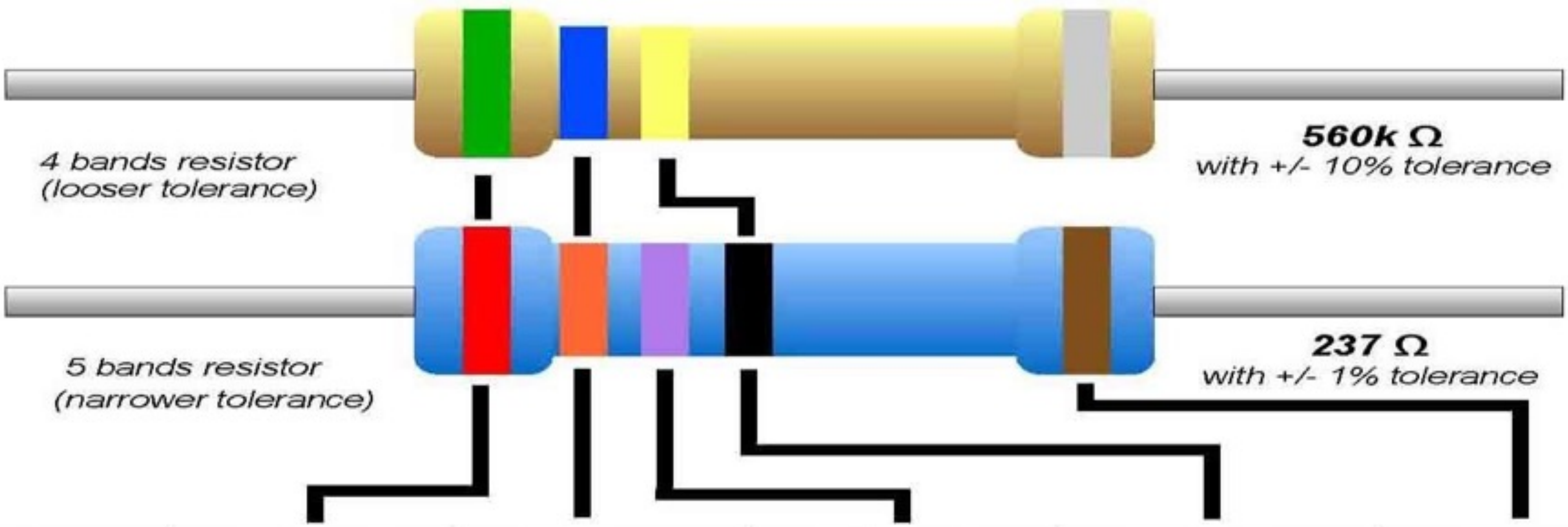


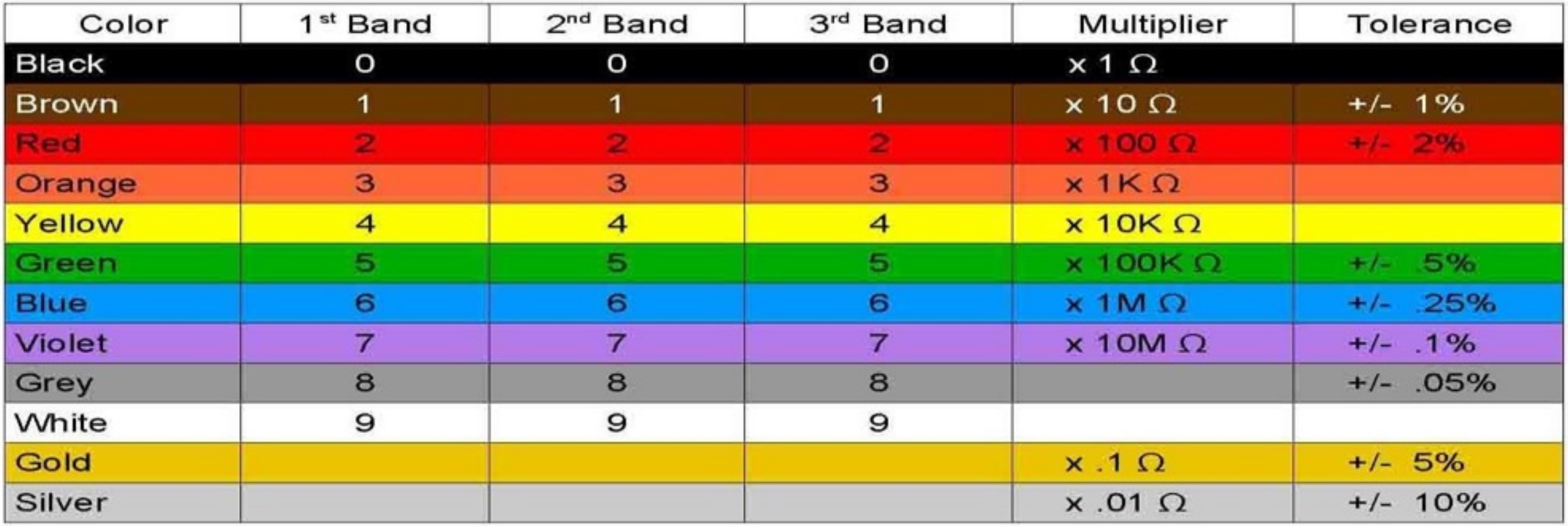
Resistance (R)

How easily can the current flow?

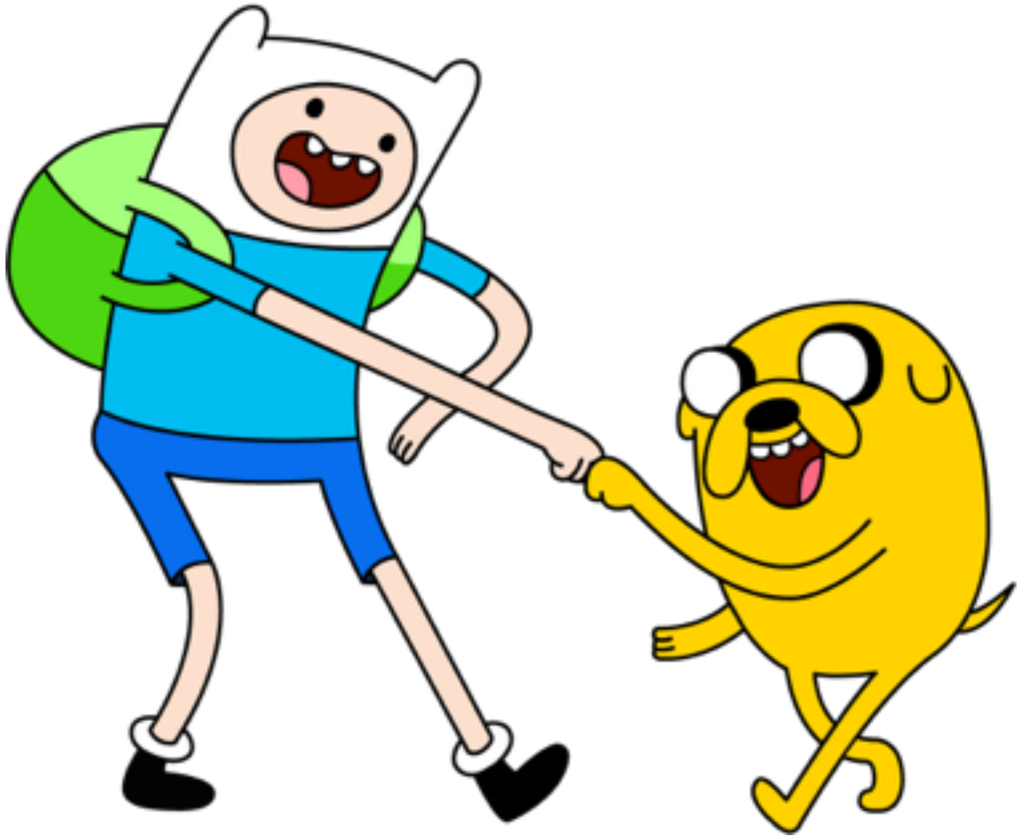

5%4W
180ΩJW
IRC 8938 PW5A
4Ω 10% P-711

Resistor Color Code





Color	1st Band	2nd Band	3rd Band	Multiplier	Tolerance
Black	0	0	0	x 1 Ω	
Brown	1	1	1	x 10 Ω	+/- 1%
Red	2	2	2	x 100 Ω	+/- 2%
Orange	3	3	3	x 1K Ω	
Yellow	4	4	4	x 10K Ω	
Green	5	5	5	x 100K Ω	+/- .5%
Blue	6	6	6	x 1M Ω	+/- .25%
Violet	7	7	7	x 10M Ω	+/- .1%
Grey	8	8	8		+/- .05%
White	9	9	9		
Gold				x .1 Ω	+/- 5%
Silver				x .01 Ω	+/- 10%



1. What’s a circuit?
2. Which foot of the LED is positive
3. What’s a resistor?

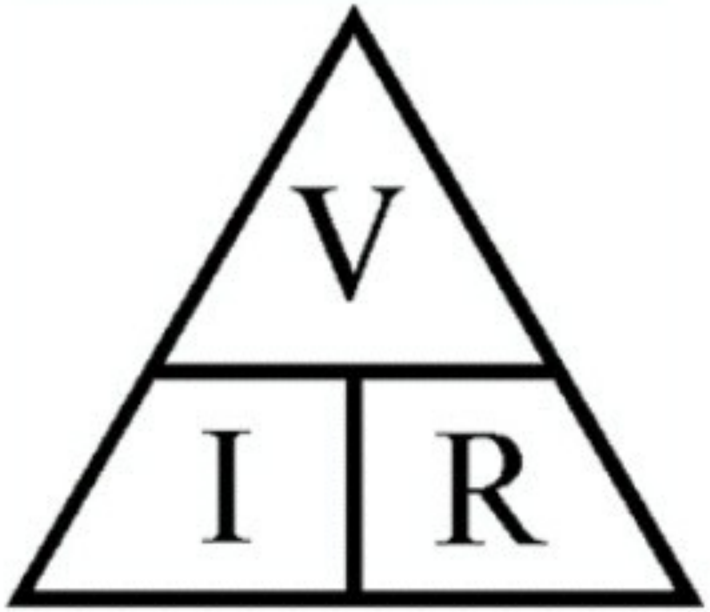
Ohm's law

- Ohm's law says *that the tension is equal to the product of the intensity and the resistance*

$$V = R \cdot I$$

- *This is equivalent to:*

$$I=V/R \leftrightarrow R=V/I$$



Index

How much power is spent?

$$P = VI$$

power is referred to as watts W

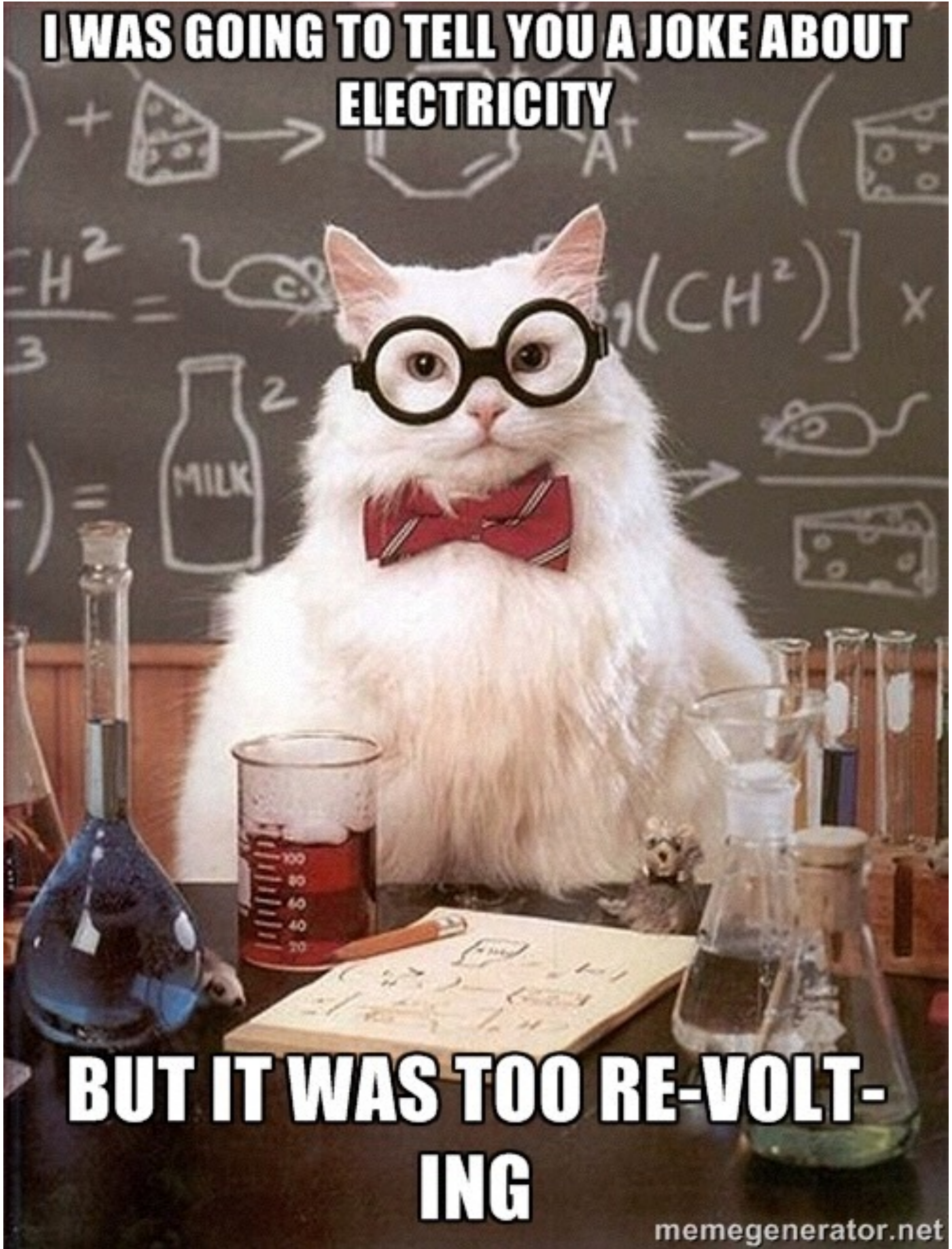
The power goes into heat usually or sometimes mechanical work (like a robot motor)

this is why your laptop can get hot

mechanical work = **motor**

radiated energy = **lamps, transmitters**

stored energy = **battery, capacitors, inductors**


I WAS GOING TO TELL YOU A JOKE ABOUT ELECTRICITY
MILK
BUT IT WAS TOO RE-VOLT-ING
memegenerator.net

And now on to the

microcontroller

Usually you’ll be prototyping on a **breadboard**

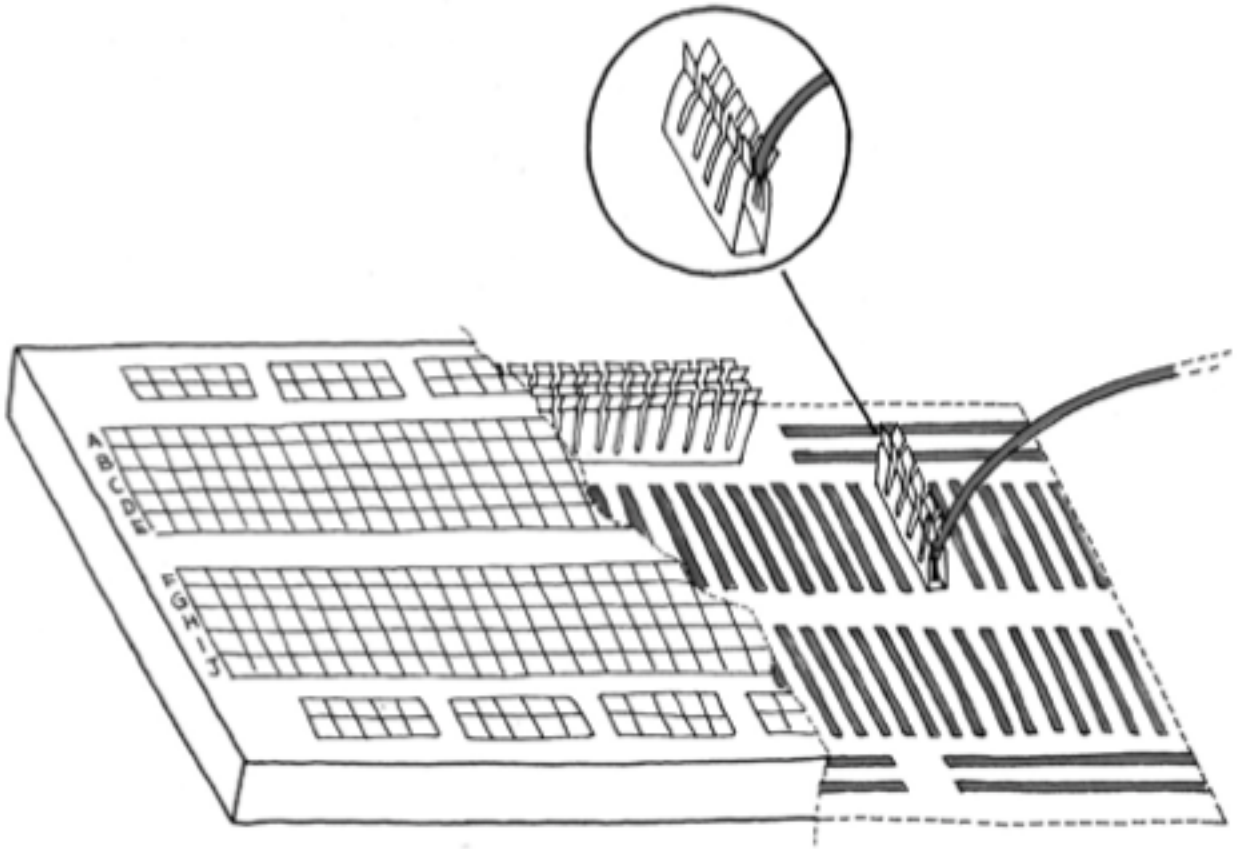
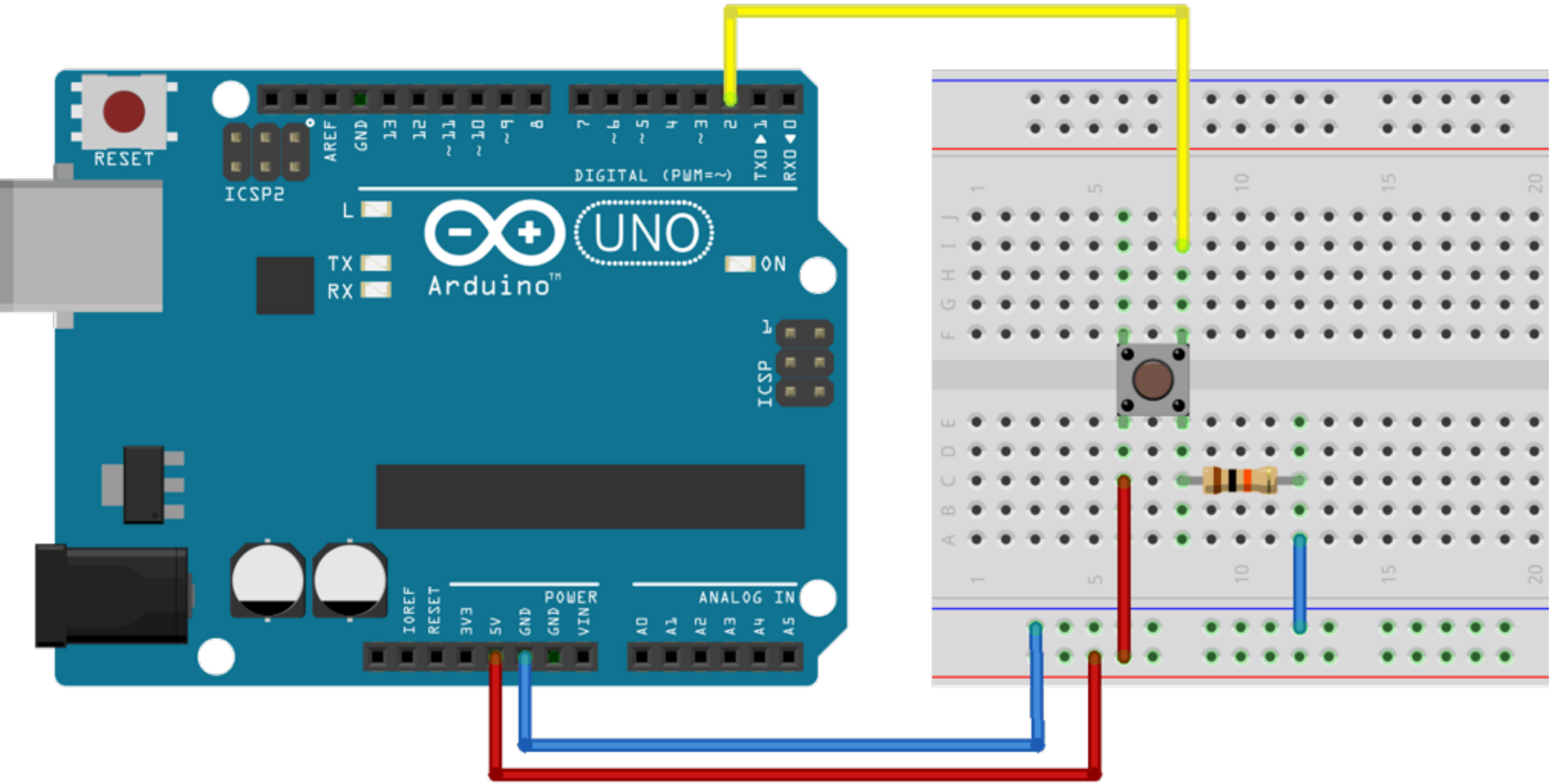
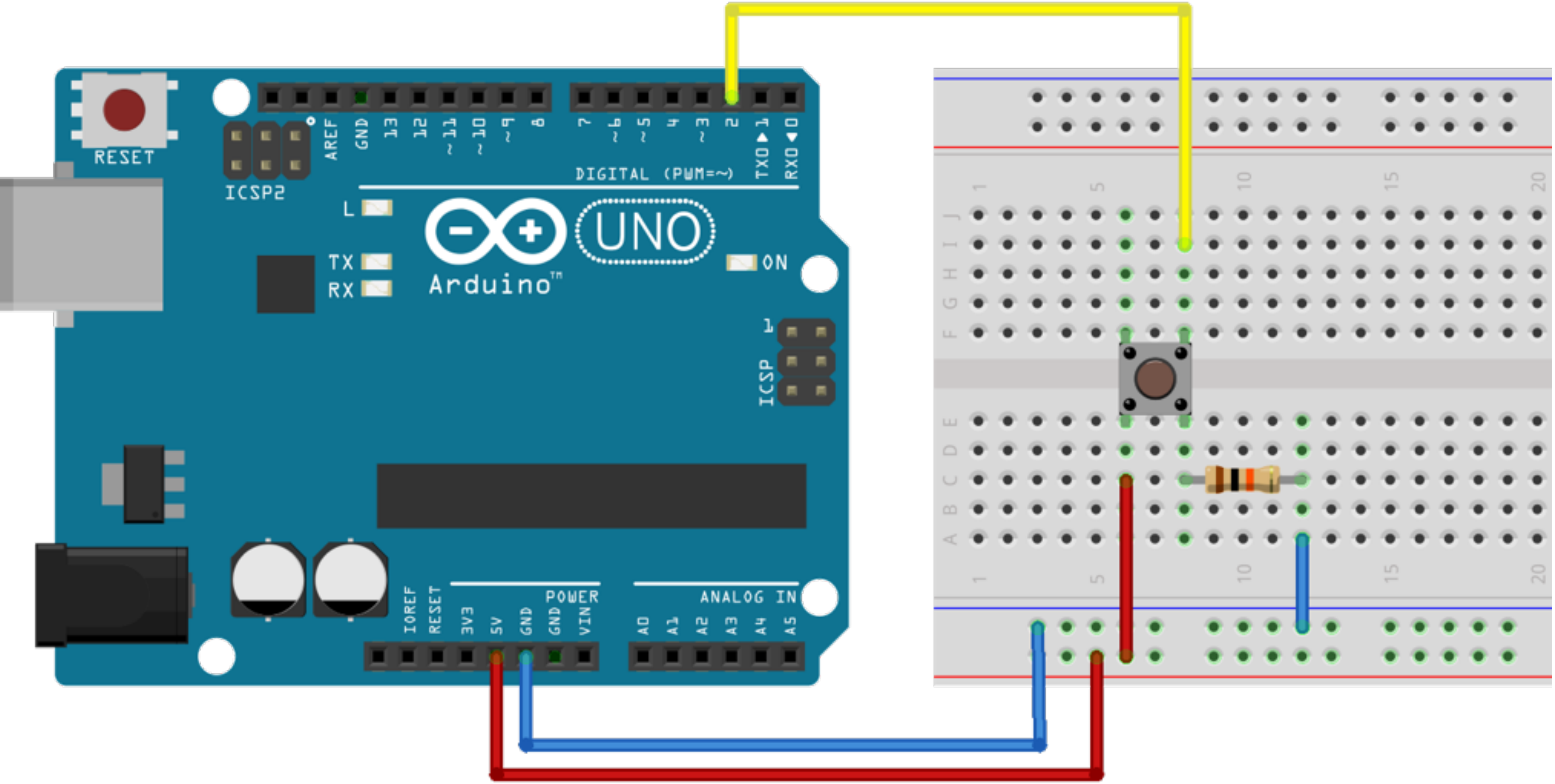


Figure A-1.
The solderless breadboard

You will be looking to connect your sensors to the **arduino pins**



If set to output, they send out **five volts** and up to **40 mA of current**



THE TWO MOST COMMON USE OF PINS

Digital & Analog* (PWM)

Get the data in

Send the data out

DIGITAL

ON/OFF

0V or 5V

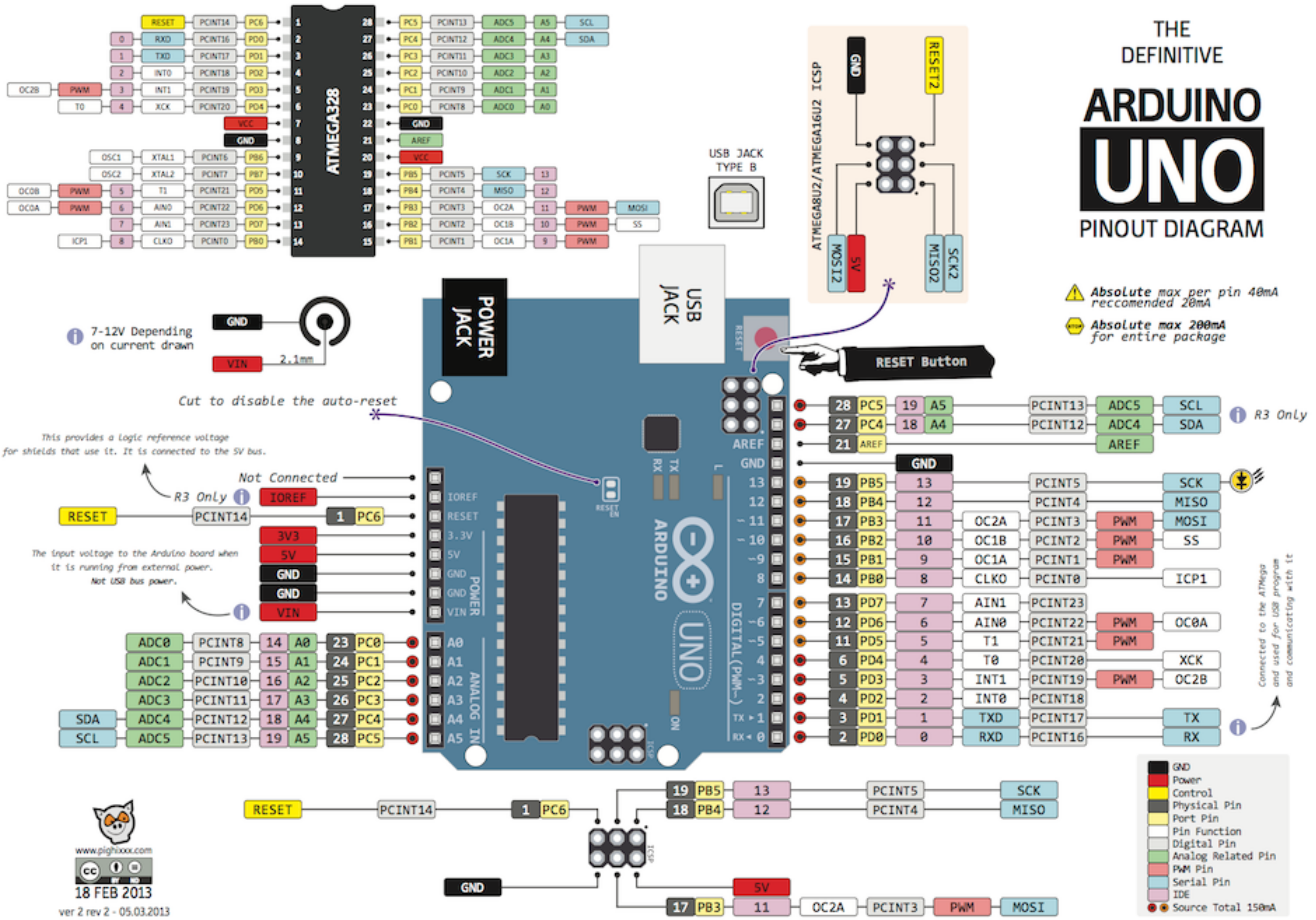
PWM / ANALOG

0-255 / 0-1024

Voltage varies between 0 and 5V.

Same with current.

THE DEFINITIVE ARDUINO UNO PINOUT DIAGRAM



⚠ **Absolute max per pin 40mA** reccomended 20mA

Absolute max 200mA for entire package

7-12V Depending on current drawn

Cut to disable the auto-reset

This provides a logic reference voltage for shields that use it. It is connected to the 5V bus.

Not Connected

R3 Only

The input voltage to the Arduino board when it is running from external power. Not USB bus power.

R3 Only

Connected to the ATMega and used for USB program and communicating with it

						ATMEGA328							
		RESET	PCINT14	PC6	1		28	PC5	PCINT13	ADC5	A5	SCL	
		0	RXD	PCINT16	PD0	2	27	PC4	PCINT12	ADC4	A4	SDA	
		1	TXD	PCINT17	PD1	3	26	PC3	PCINT11	ADC3	A3		
		2	INT0	PCINT18	PD2	4	25	PC2	PCINT10	ADC2	A2		
OC2B	PWM	3	INT1	PCINT19	PD3	5	24	PC1	PCINT9	ADC1	A1		
	T0	4	XCK	PCINT20	PD4	6	23	PC0	PCINT8	ADC0	A0		
					VCC	7	22	GND					
					GND	8	21	AREF					
		OSC1	XTAL1	PCINT6	PB6	9	20	VCC					
		OSC2	XTAL2	PCINT7	PB7	10	19	PB5	PCINT5	SCK	13		
OC0B	PWM	5	T1	PCINT21	PD5	11	18	PB4	PCINT4	MISO	12		
OC0A	PWM	6	AIN0	PCINT22	PD6	12	17	PB3	PCINT3	OC2A	11	PWM	MOSI
		7	AIN1	PCINT23	PD7	13	16	PB2	PCINT2	OC1B	10	PWM	SS
	ICP1	8	CLKO	PCINT0	PB0	14	15	PB1	PCINT1	OC1A	9	PWM	

28	PC5	19	A5	PCINT13	ADC5		SCL
27	PC4	18	A4	PCINT12	ADC4		SDA
21	AREF				AREF		
		GND					
19	PB5	13		PCINT5			SCK
18	PB4	12		PCINT4			MISO
17	PB3	11	OC2A	PCINT3	PWM		MOSI
16	PB2	10	OC1B	PCINT2	PWM		SS
15	PB1	9	OC1A	PCINT1	PWM		
14	PB0	8	CLKO	PCINT0			ICP1
13	PD7	7	AIN1	PCINT23			
12	PD6	6	AIN0	PCINT22	PWM		OC0A
11	PD5	5	T1	PCINT21	PWM		
6	PD4	4	T0	PCINT20			XCK
5	PD3	3	INT1	PCINT19	PWM		OC2B
4	PD2	2	INT0	PCINT18			
3	PD1	1	TXD	PCINT17			TX
2	PD0	0	RXD	PCINT16			RX

						Not Connected
						IOREF
RESET		PCINT14		1	PC6	
						3V3
						5V
						GND
						GND
						VIN
	ADC0	PCINT8	14	A0	23	PC0
	ADC1	PCINT9	15	A1	24	PC1
	ADC2	PCINT10	16	A2	25	PC2
	ADC3	PCINT11	17	A3	26	PC3
SDA	ADC4	PCINT12	18	A4	27	PC4
SCL	ADC5	PCINT13	19	A5	28	PC5

ICSP

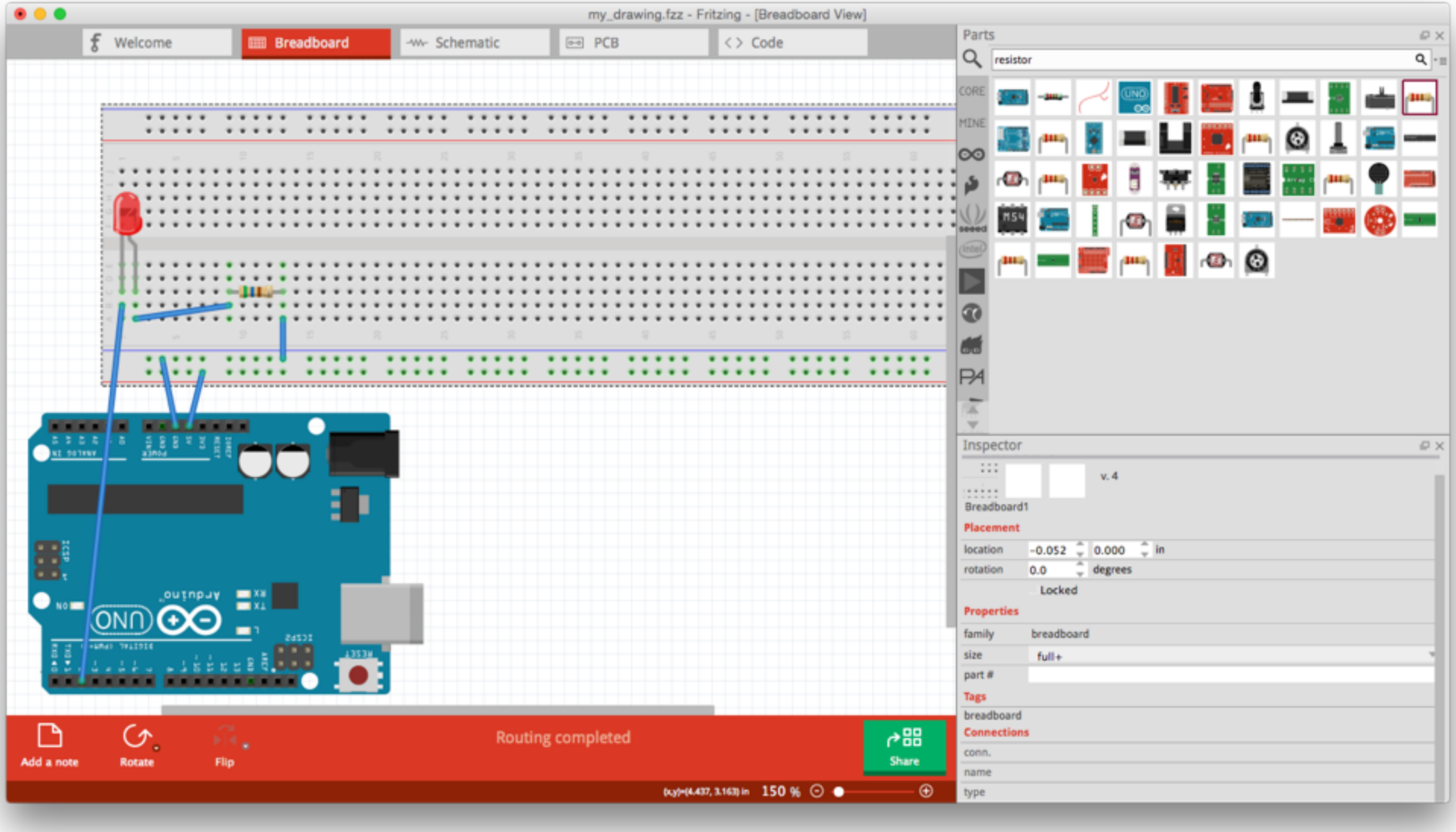
19	PB5	13		PCINT5	SCK
18	PB4	12		PCINT4	MISO
RESET	PCINT14	1	PC6		
GND					
		5V			
17	PB3	11	OC2A	PCINT3	PWM	MOSI

⬛	GND
🟥	Power
🟨	Control
⬛	Physical Pin
🟨	Port Pin
⬜	Pin Function
⬜	Digital Pin
🟩	Analog Related Pin
🟥	PWM Pin
🟦	Serial Pin
🟪	IDE
● ●	Source Total 150mA

www.pighixxx.com

18 FEB 2013

ver 2 rev 2 - 05.03.2013



my_drawing.fzz - Fritzing - [Breadboard View]

resistor

v. 4

Breadboard1

Placement

location -0.052 0.000 in

rotation 0.0 degrees

Locked

Properties

family breadboard

size full+

part #

Tags

breadboard

Connections

conn.

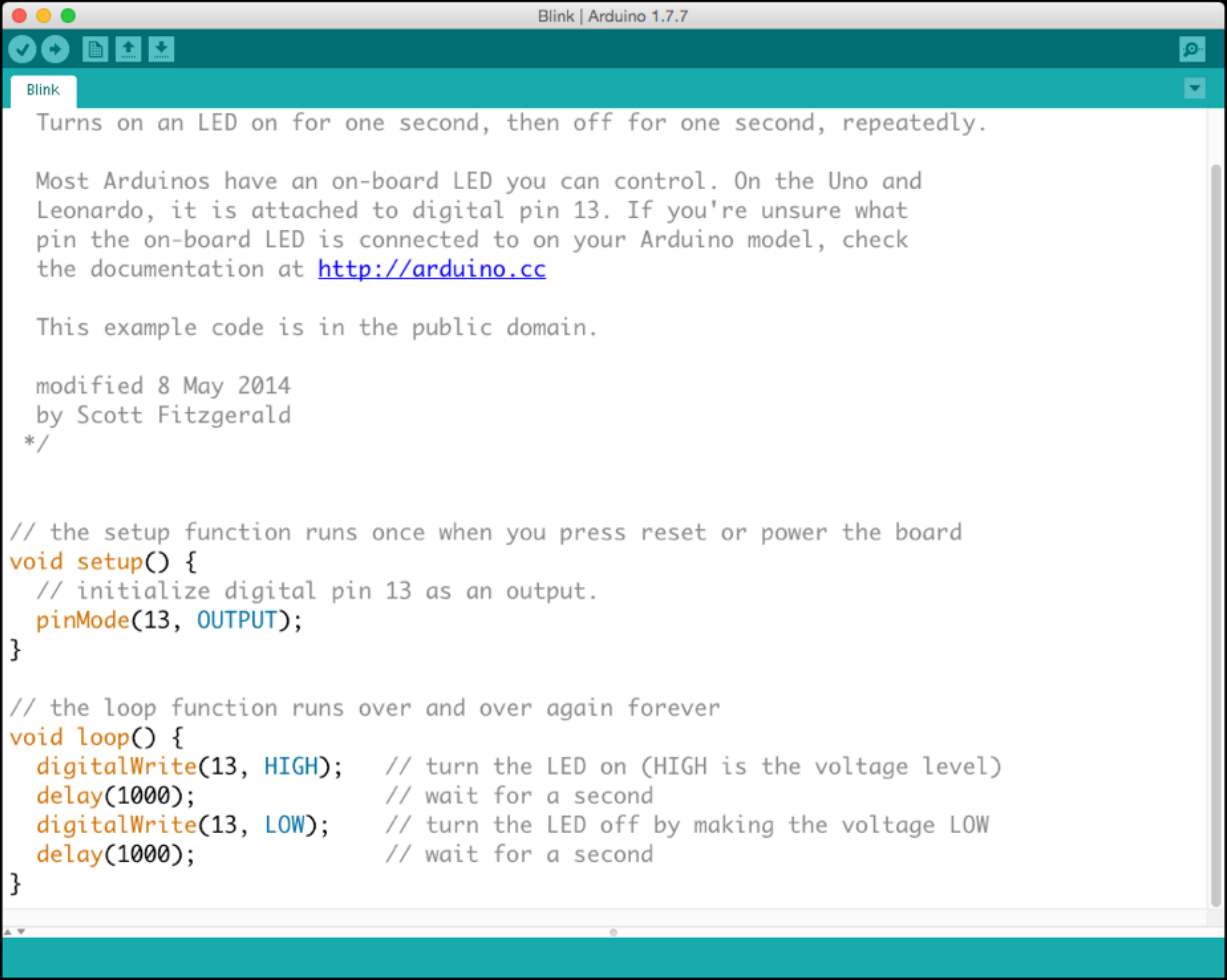
name

type

Routing completed

(x,y)=(4.437, 3.163) in 150 %

http://fritzing.org/home/



```
  Turns on an LED on for one second, then off for one second, repeatedly.

  Most Arduinos have an on-board LED you can control. On the Uno and
  Leonardo, it is attached to digital pin 13. If you're unsure what
  pin the on-board LED is connected to on your Arduino model, check
  the documentation at http://arduino.cc

  This example code is in the public domain.

  modified 8 May 2014
  by Scott Fitzgerald
 */


// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin 13 as an output.
  pinMode(13, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(13, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);              // wait for a second
}
```

Arduino has two main loops just like processing.

1. setup(){}

Set your pins up here as input or output using the pinMode function.

signature: `pinMode(pinNumber, MODE)`

Mode is either `INPUT` or `OUTPUT` mainly…

2. loop(){}

Write or read to your pins and do any timing or computation.

Steps to get / send data for each pin

1. Create an int for the pin number outside the scope of your functions
2. Set the pinMode as input or output in setup()
3. Write to the pin or read from pin in loop()
4. If you read, you'll want to save that data to another variable in loop()

BUILDING A HEALTHY **HACKER SPACE**

https://wiki.hackerspaces.org/Hackerspaces

Phone

RESOURCES

http://www.allaboutcircuits.com/

MAKE MAGAZINE

INSTRUCTABLES

ADAFRUIT TUTORIALS