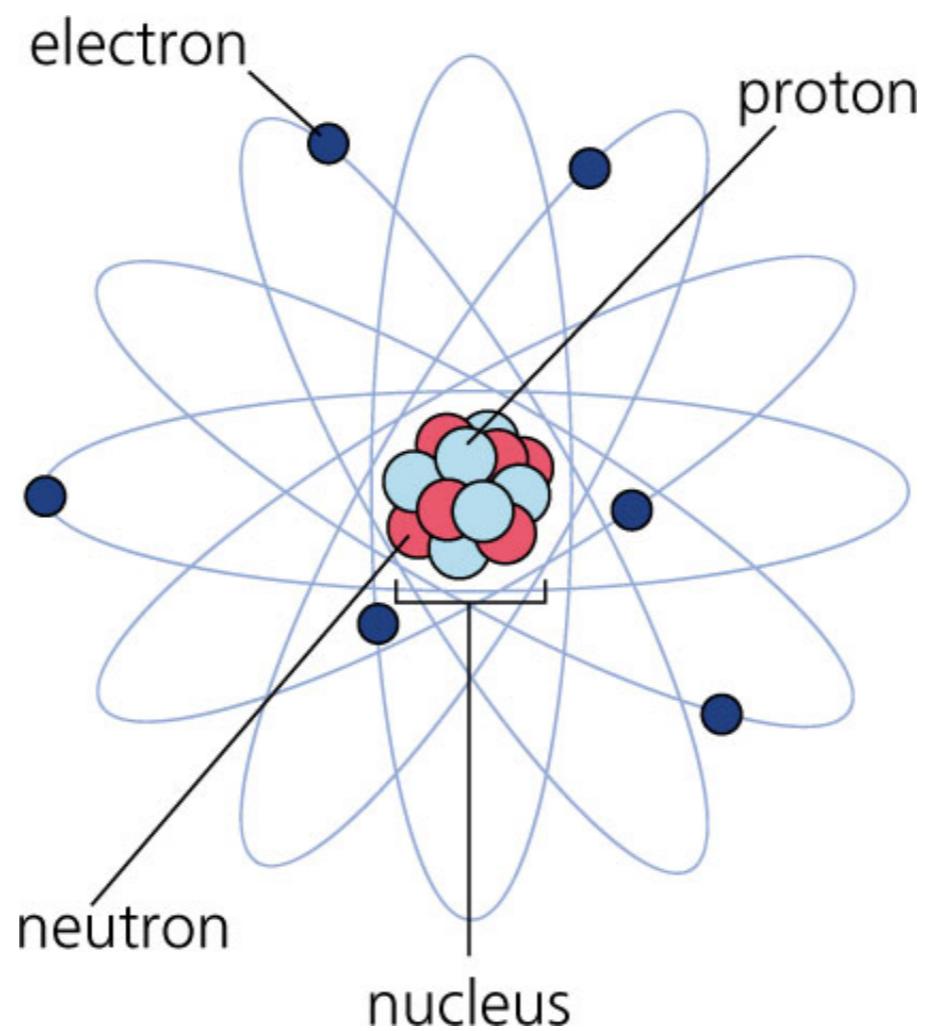


WELCOME TO THE DUCK TAPE FILES

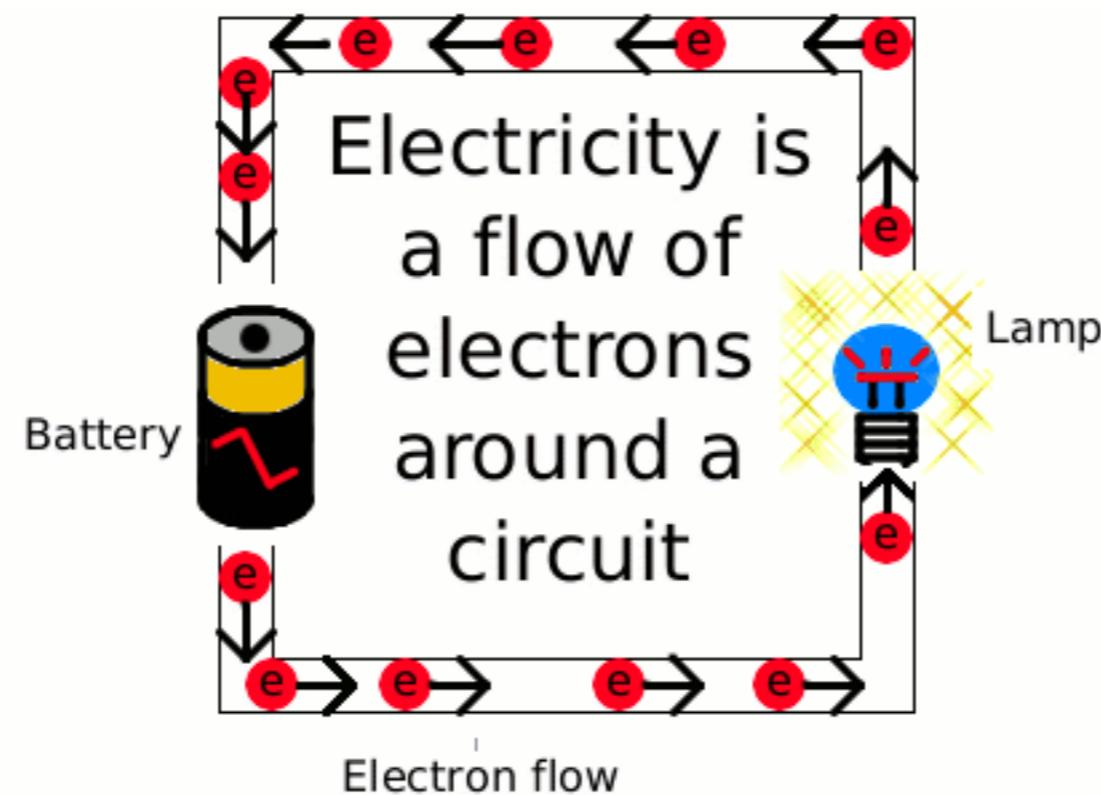
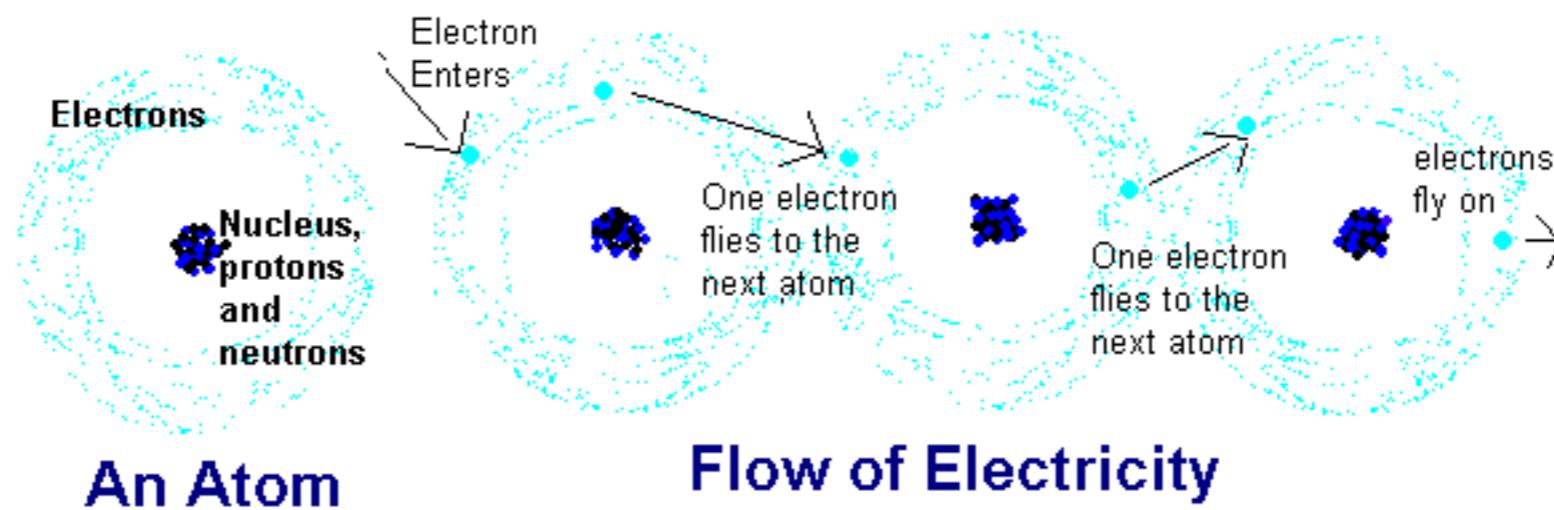


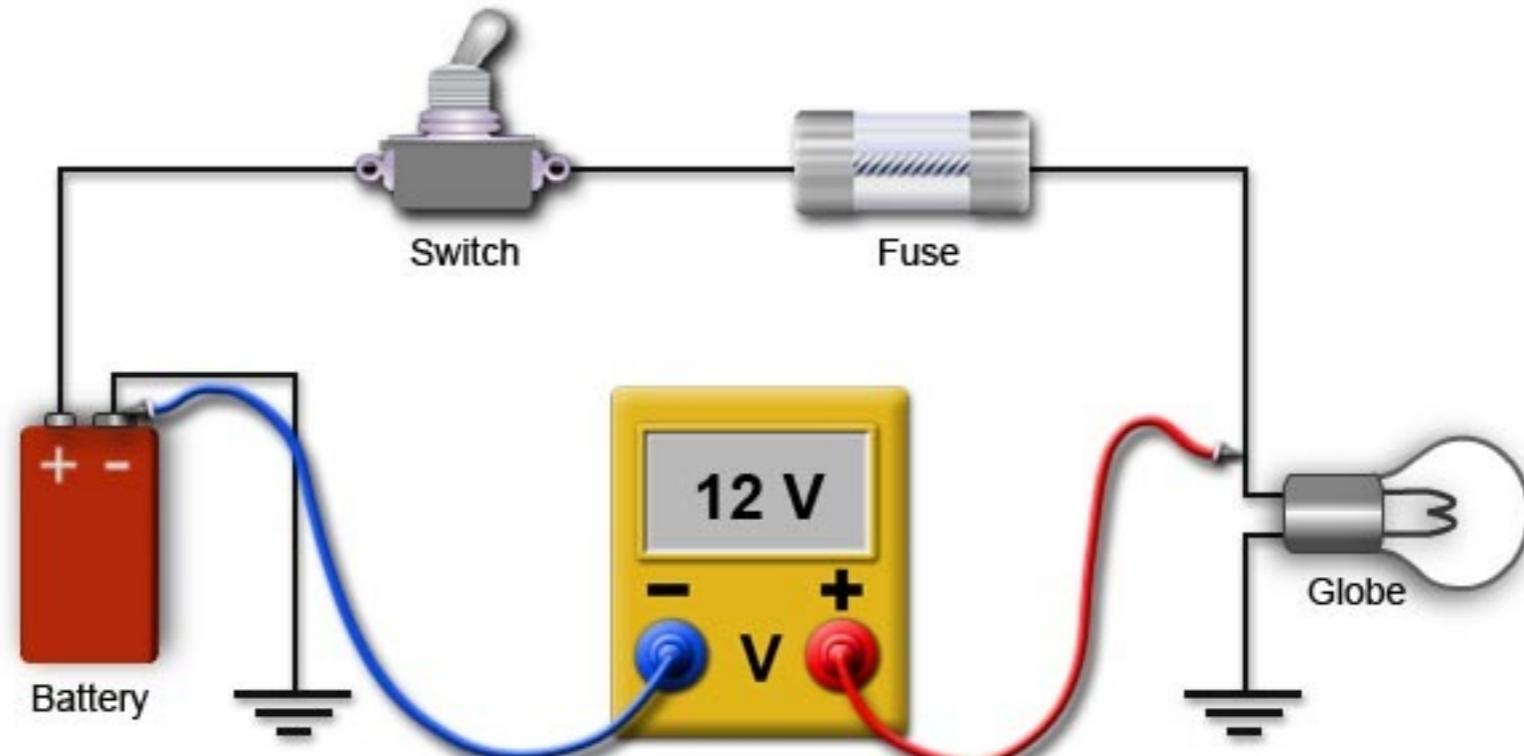
FAILURE IS
LEARNING

It's all about balancing the
electrons....



Nature likes
balance





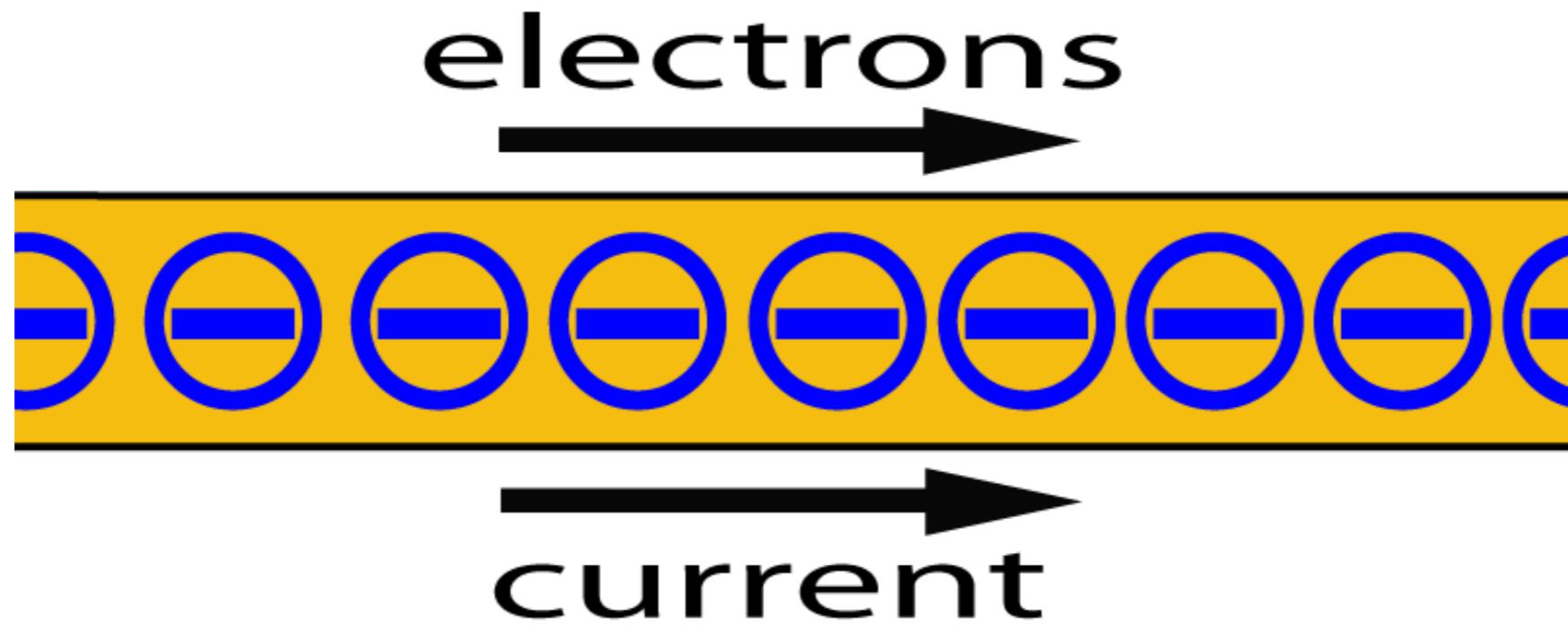
Voltage (V)

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?



KEEP
CALM
ITS
QUESTION
TIME



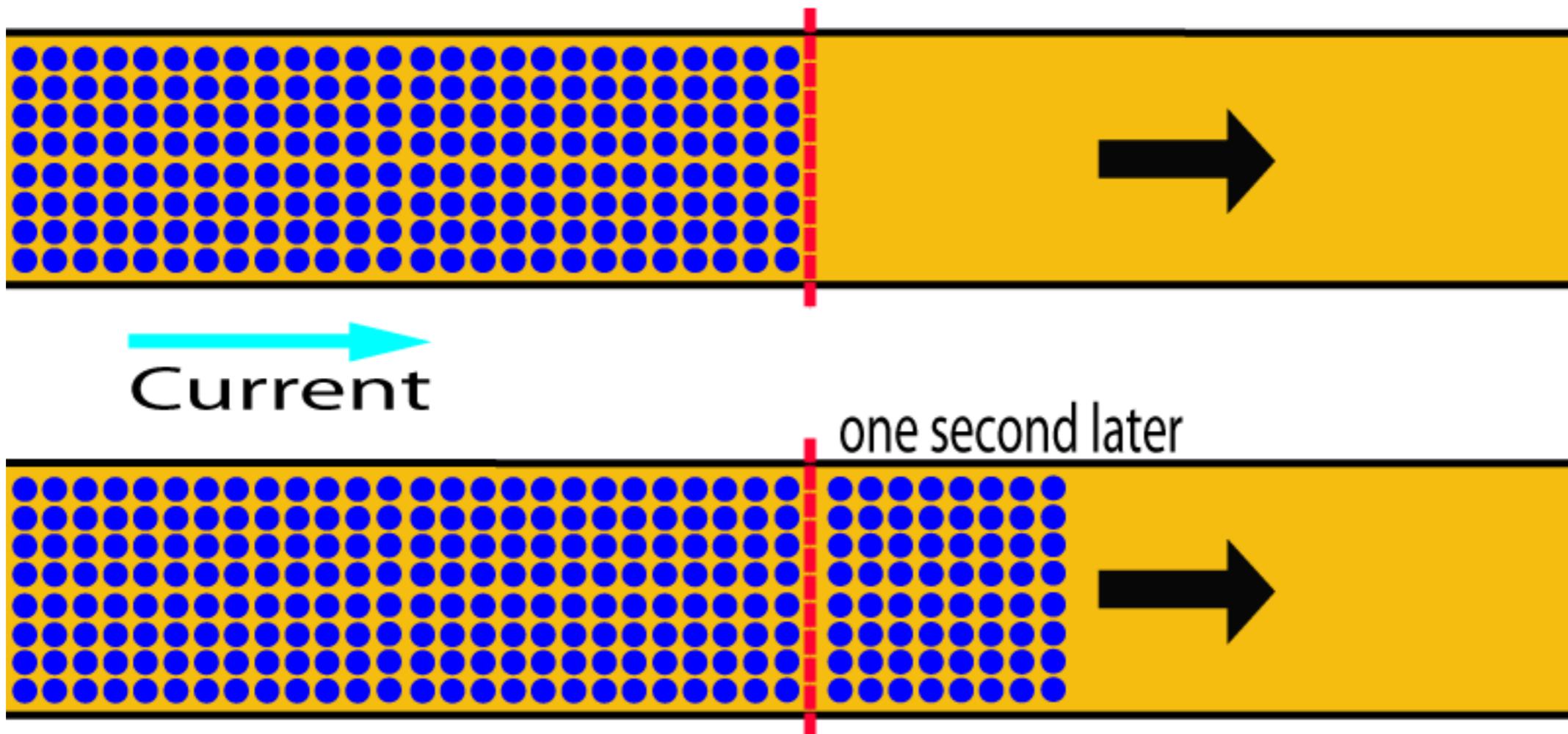
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Current (I)

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

Amperes (Amps)

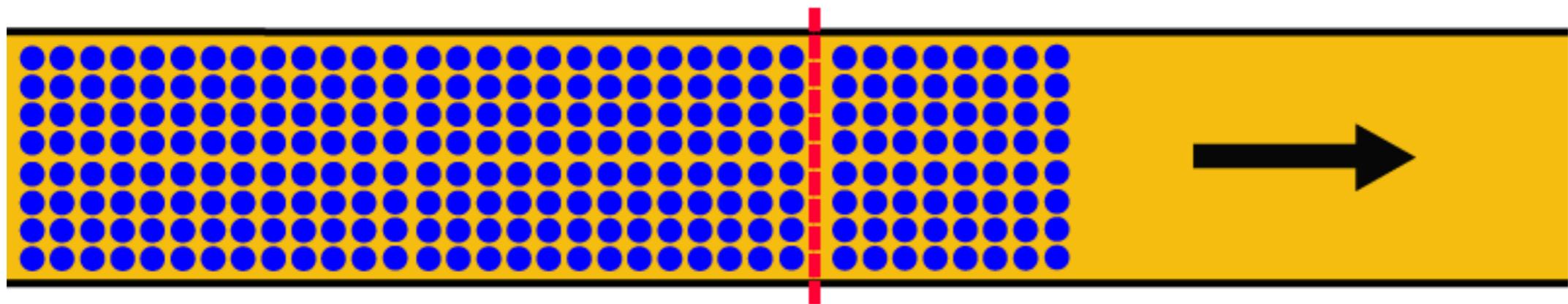
Current is measured in units called ‘amperes’. The number of amperes in a wire relates to how many electrons pass a cross section of the wire per second.



| 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} | 1 000 000 000 000 000 000 000 000 | Sextillion | Trilliard | 1991 |
| exa | E | 1000^6 | 10^{18} | 1 000 000 000 000 000 000 000 000 | Quintillion | Trillion | 1975 |
| peta | P | 1000^5 | 10^{15} | 1 000 000 000 000 000 000 000 000 | Quadrillion | Billiard | 1975 |
| tera | T | 1000^4 | 10^{12} | 1 000 000 000 000 000 000 000 000 | Trillion | Billion | 1960 |
| giga | G | 1000^3 | 10^9 | 1 000 000 000 000 000 000 000 000 | Billion | Milliard | 1960 |
| mega | M | 1000^2 | 10^6 | 1 000 000 000 000 000 000 000 000 | | Million | 1960 |
| kilo | k | 1000^1 | 10^3 | 1 000 000 000 000 000 000 000 000 | 1 000 | Thousand | 1795 |
| hecto | h | $1000^{2/3}$ | 10^2 | 1 000 000 000 000 000 000 000 000 | 100 | Hundred | 1795 |
| deca | da | $1000^{1/3}$ | 10^1 | 1 000 000 000 000 000 000 000 000 | 10 | Ten | 1795 |
| | | 1000^0 | 10^0 | 1 000 000 000 000 000 000 000 000 | 1 | One | — |
| deci | d | $1000^{-1/3}$ | 10^{-1} | 1 000 000 000 000 000 000 000 000 | 0.1 | Tenth | 1795 |
| centi | c | $1000^{-2/3}$ | 10^{-2} | 1 000 000 000 000 000 000 000 000 | 0.01 | Hundredth | 1795 |
| milli | m | 1000^{-1} | 10^{-3} | 1 000 000 000 000 000 000 000 000 | 0.001 | Thousandth | 1795 |
| micro | μ | 1000^{-2} | 10^{-6} | 1 000 000 000 000 000 000 000 000 | 0.000 001 | Millionth | 1960 |
| nano | n | 1000^{-3} | 10^{-9} | 1 000 000 000 000 000 000 000 000 | 0.000 000 001 | Billionth | 1960 |
| pico | p | 1000^{-4} | 10^{-12} | 1 000 000 000 000 000 000 000 000 | 0.000 000 000 001 | Trillionth | 1960 |
| femto | f | 1000^{-5} | 10^{-15} | 1 000 000 000 000 000 000 000 000 | 0.000 000 000 000 001 | Quadrillionth | 1964 |
| atto | a | 1000^{-6} | 10^{-18} | 1 000 000 000 000 000 000 000 000 | 0.000 000 000 000 000 001 | Quintillionth | 1964 |
| zepto | z | 1000^{-7} | 10^{-21} | 1 000 000 000 000 000 000 000 000 | 0.000 000 000 000 000 000 001 | Sextillionth | 1991 |
| yocto | y | 1000^{-8} | 10^{-24} | 1 000 000 000 000 000 000 000 000 | 0.000 000 000 000 000 000 000 001 | Septillionth | 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
electrons across it per second!**

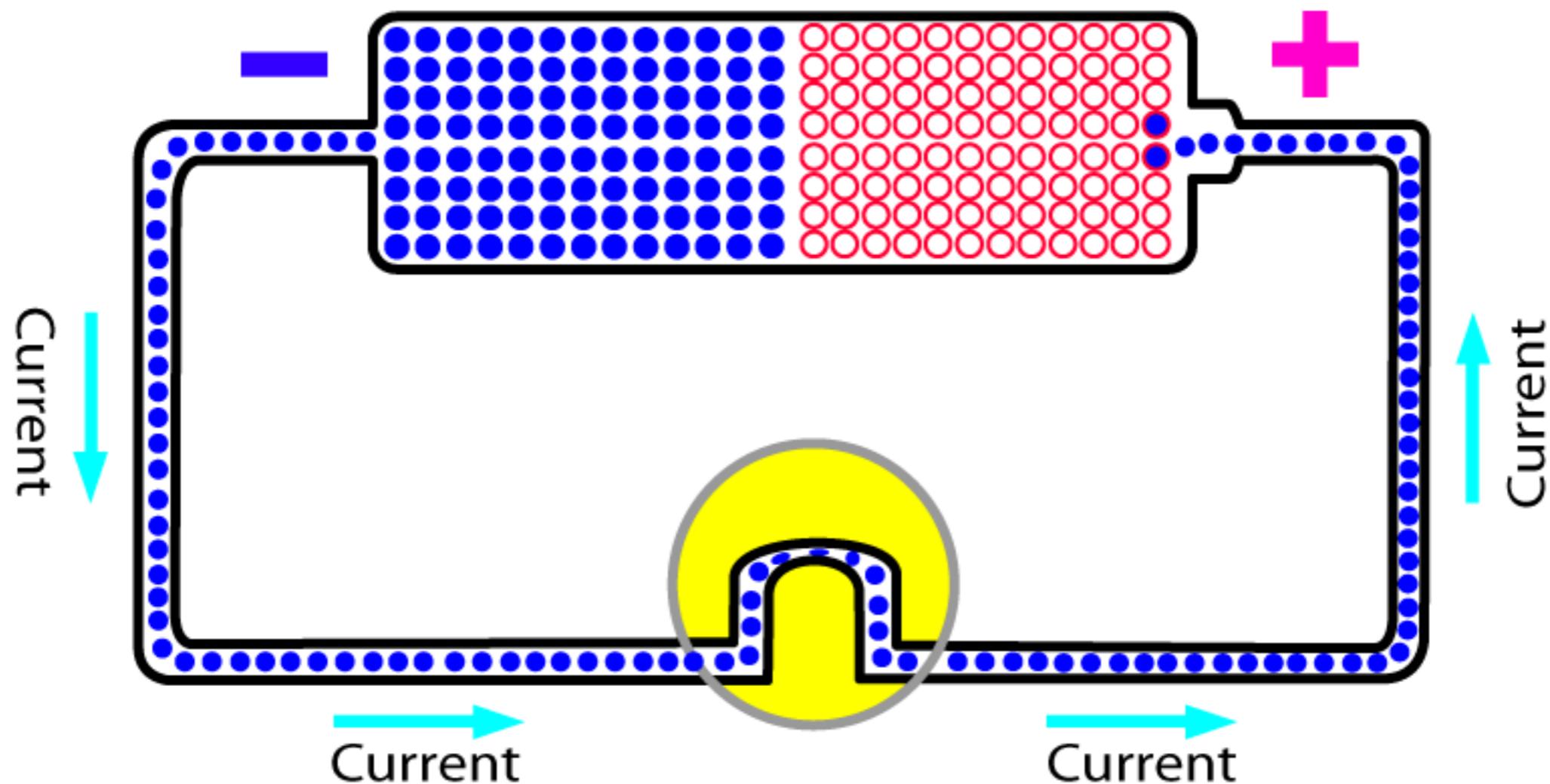
STOP



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

HAMMER TIME

What's a circuit?

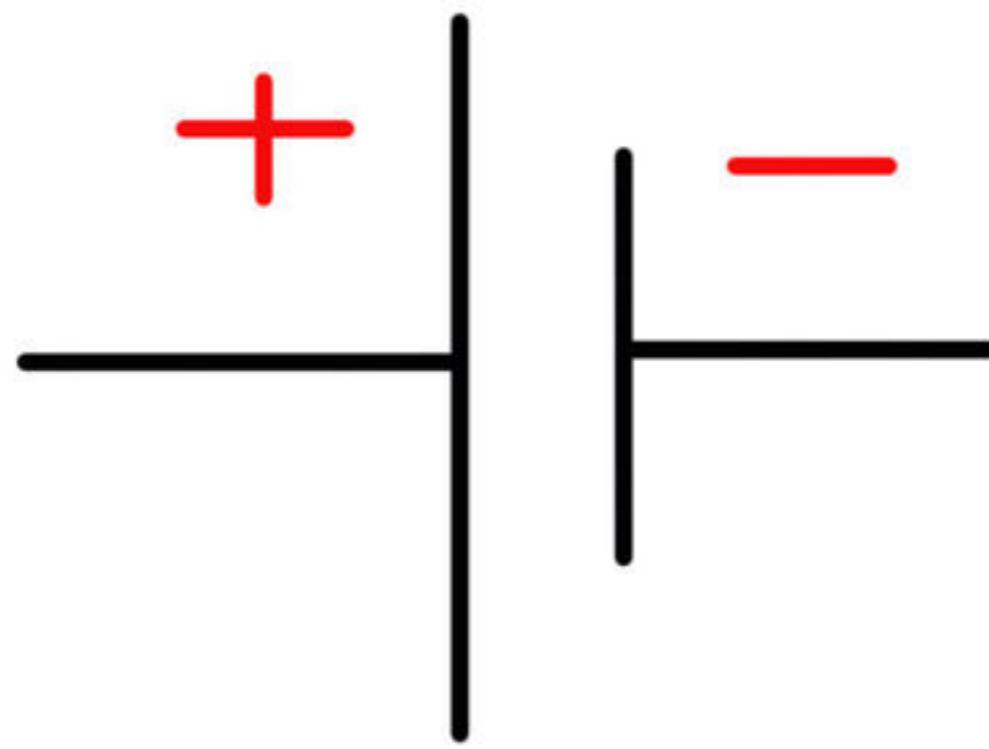


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negative positive

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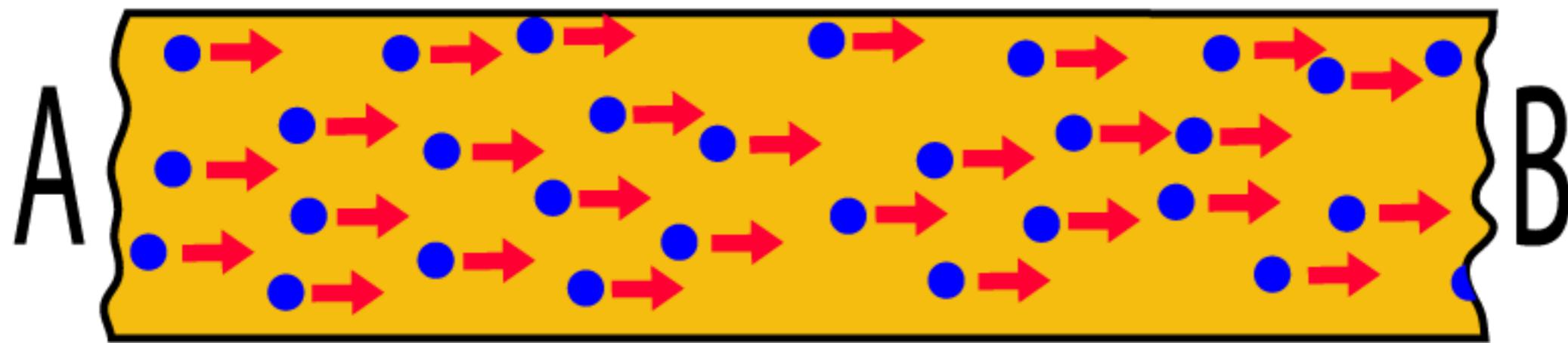
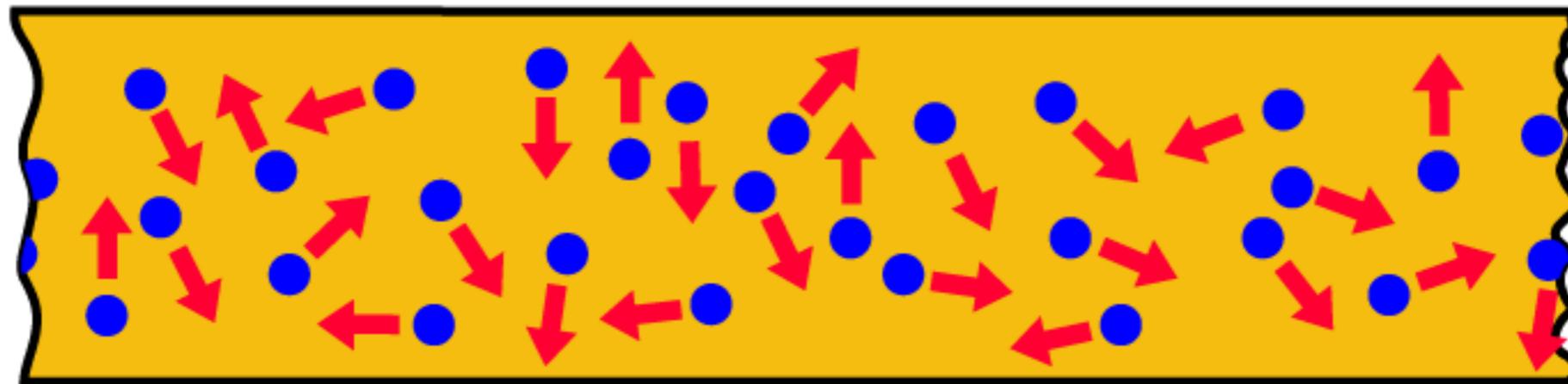


BATTERY



longer lead is positive.

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

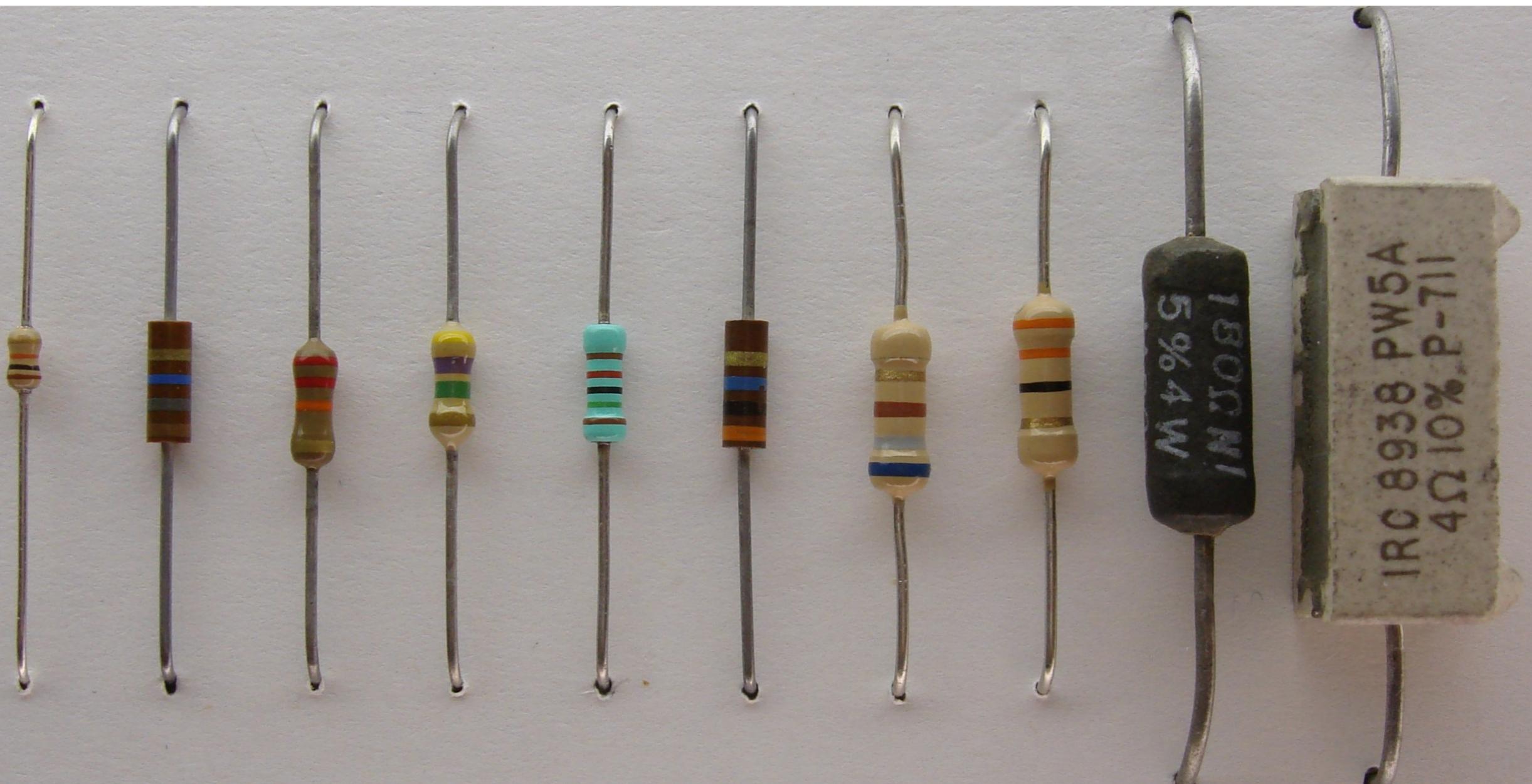


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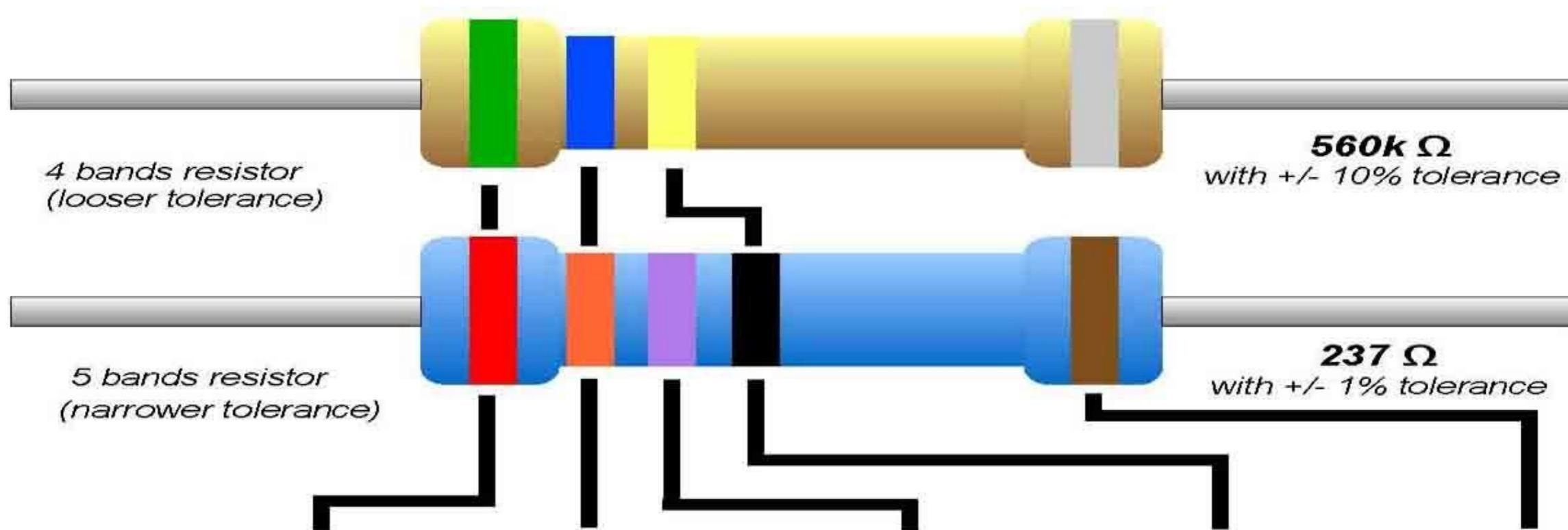


Resistance (R)

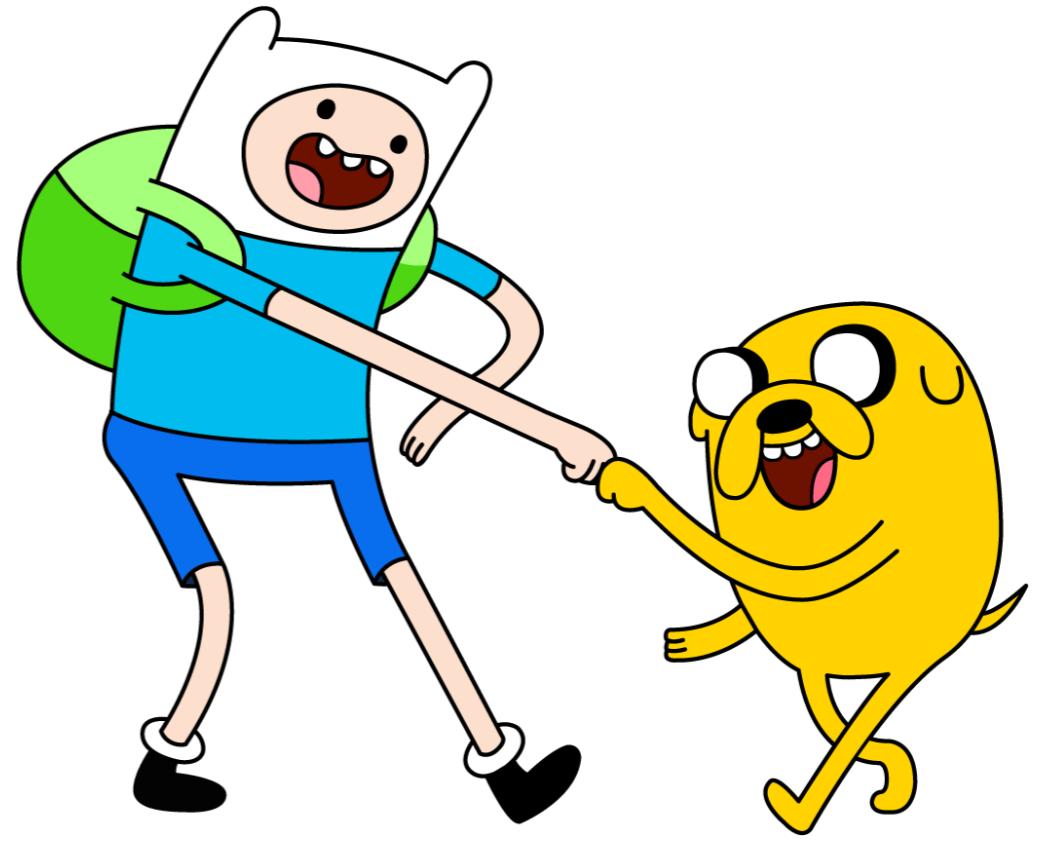
How easily can the current flow?



Resistor Color Code



| Color | 1 st Band | 2 nd Band | 3 rd 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?

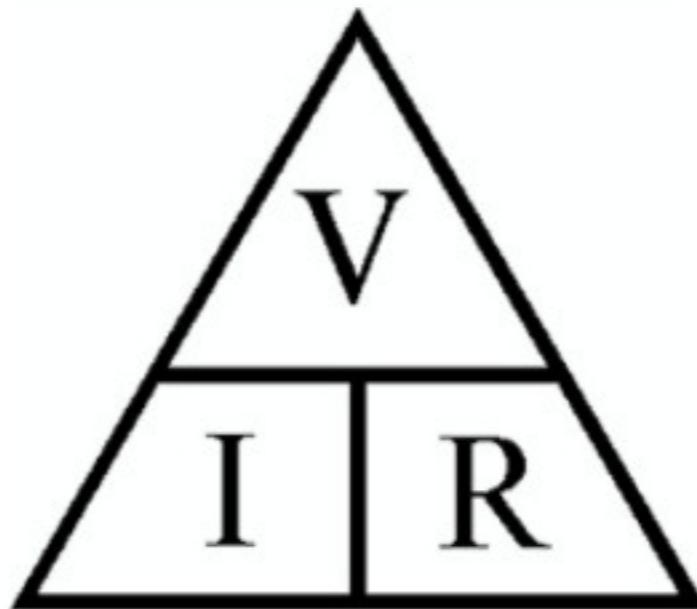
Ohm's law

- 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)

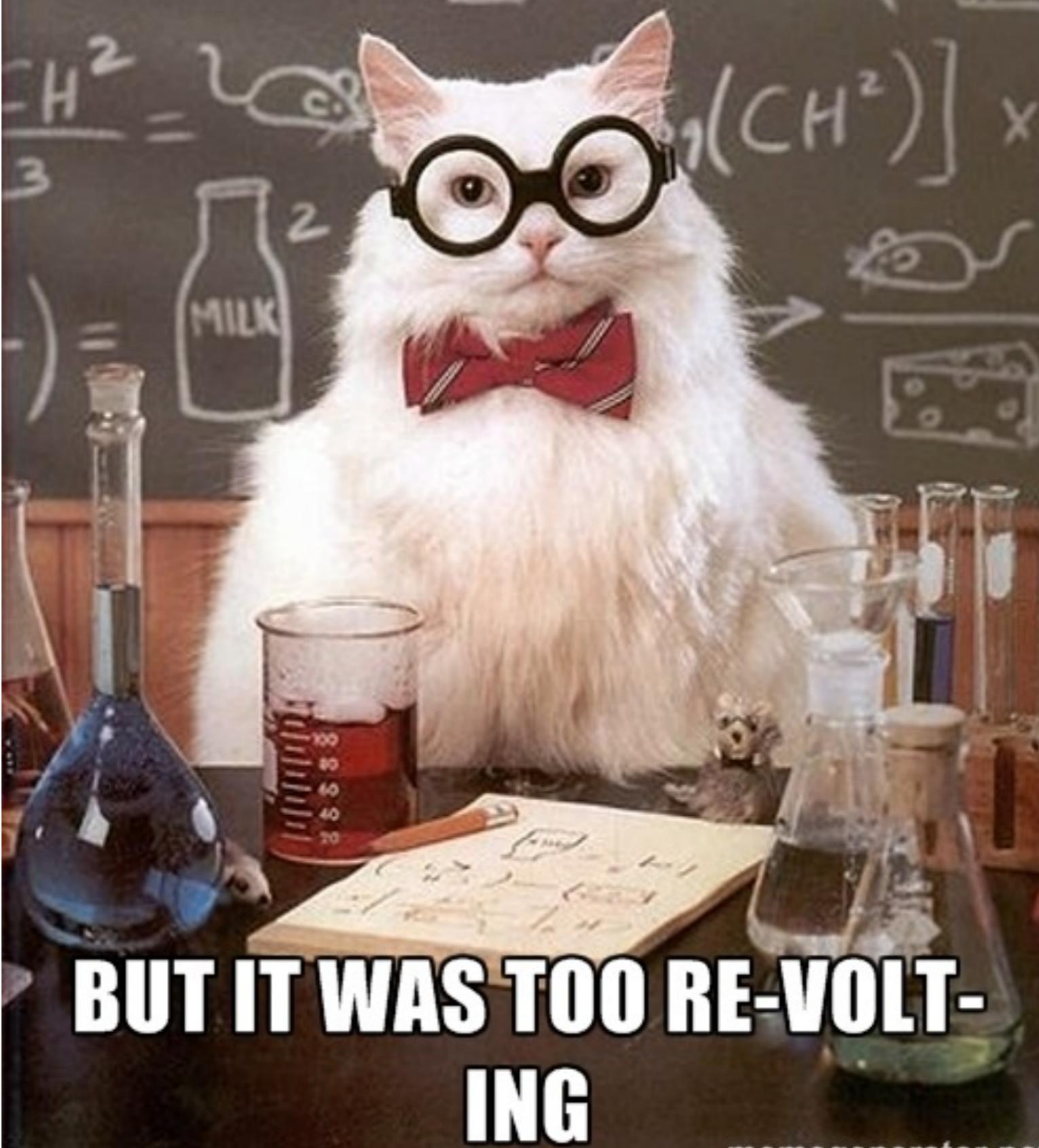
this is why your laptop can get hot

mechanical work = motor

radiated energy = lamps, transmitters

stored energy = battery, capacitors, inductors

I WAS GOING TO TELL YOU A JOKE ABOUT
ELECTRICITY



BUT IT WAS TOO RE-VOLT-
ING

And now on to the
microcontroller

Usually you'll be prototyping on a breadboard

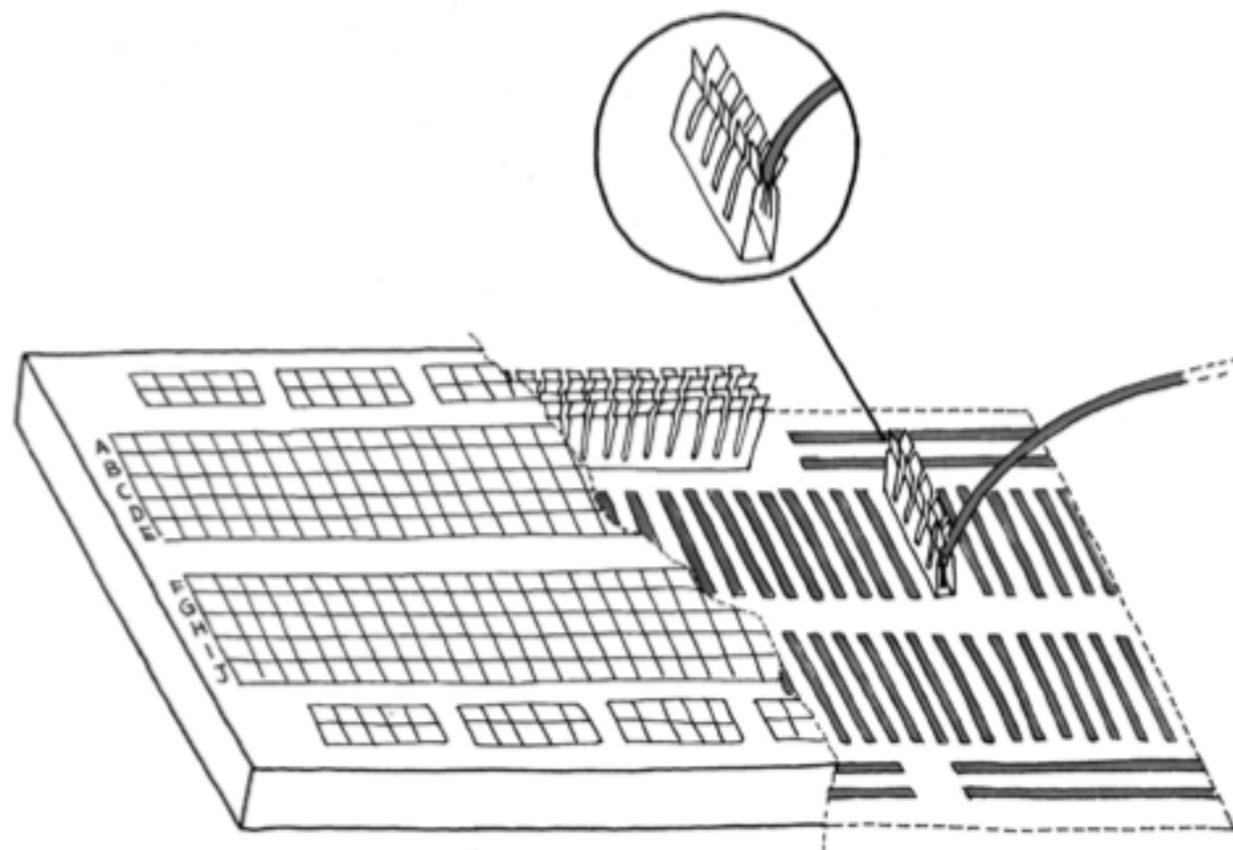
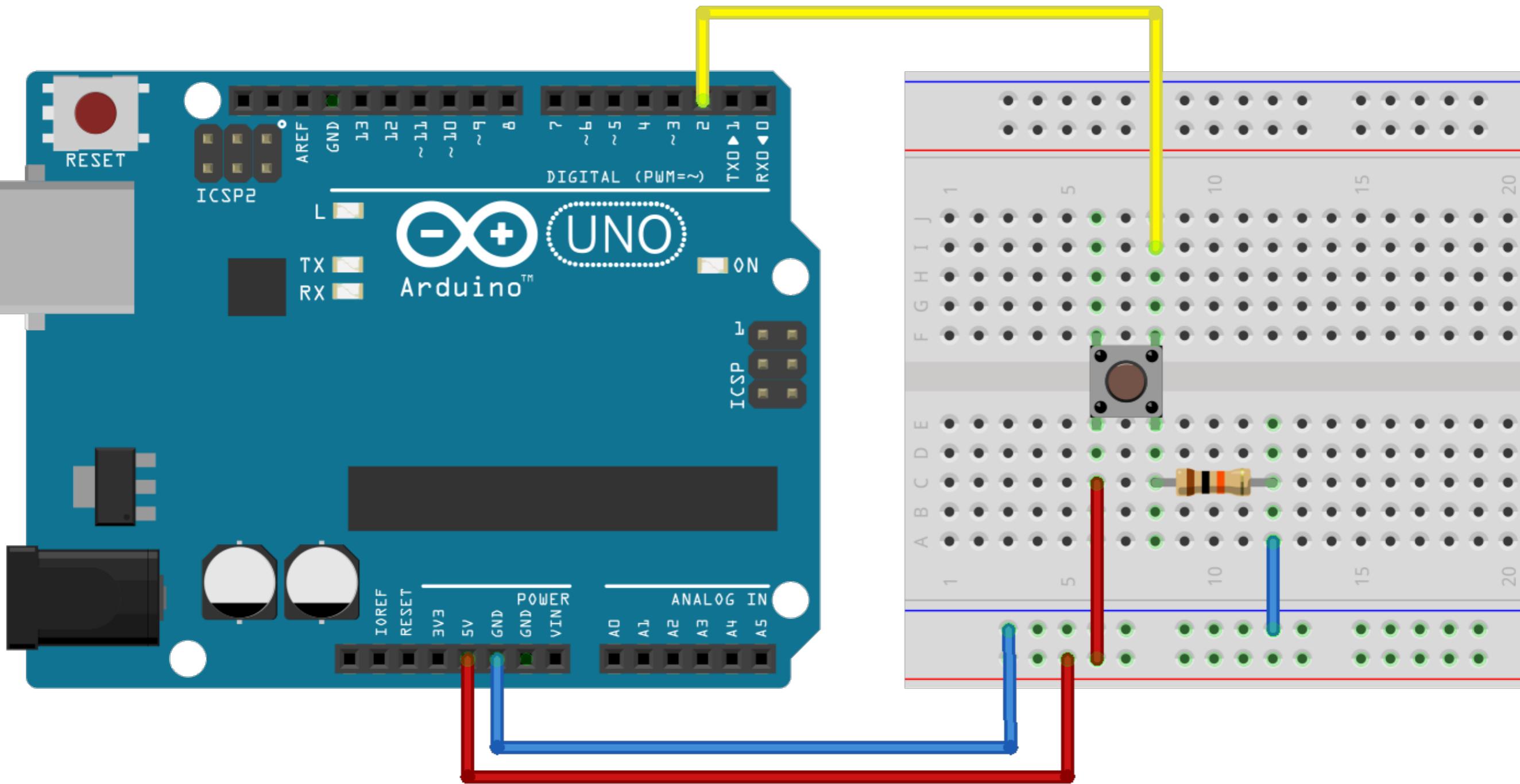
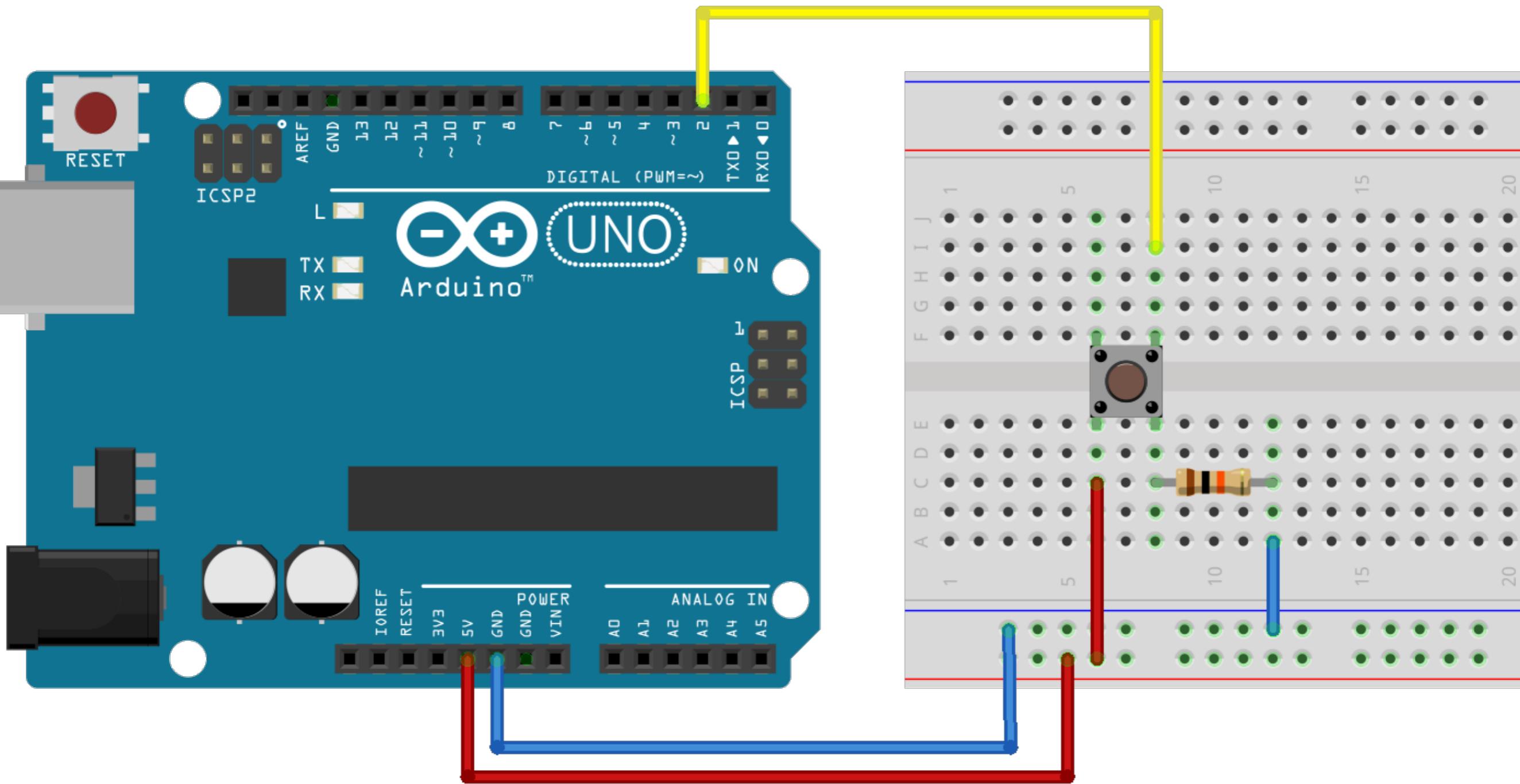


Figure A-1.
The solderless breadboard

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



If set to output, they send out **five volts** and up to **50 mA** of current



THE TWO MOST COMMON USE OF
PINS

Digital & Analog* (PWM)

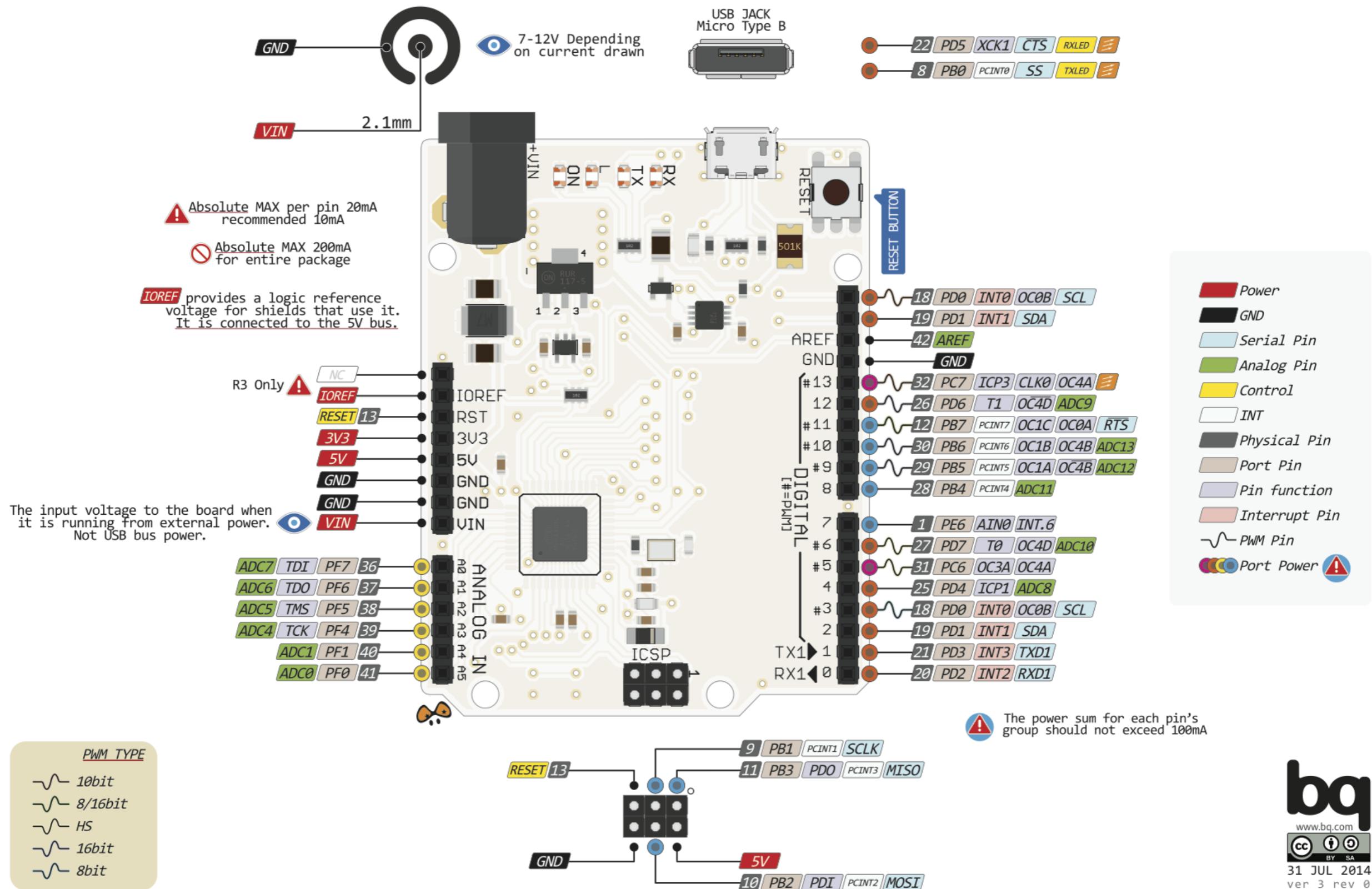
Get the data in
Send the data out

DIGITAL
ON/OFF
0V or 5V

PWM / ANALOG
0-255 / 0-1023

Voltage varies between 0 and 5V.
Same with current.

LEONARDO PINOUT





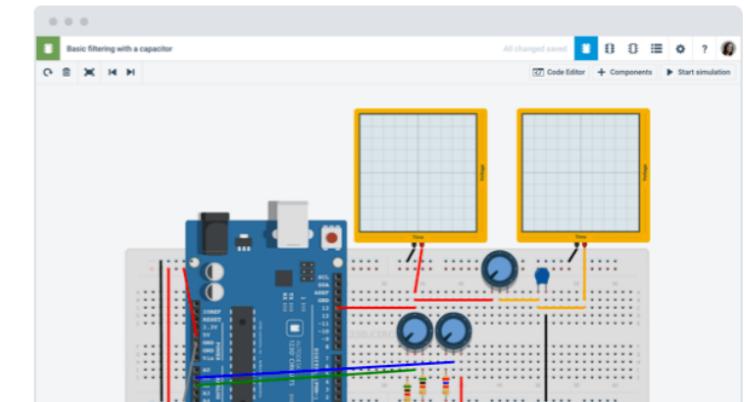
Bring your ideas to life

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Electronics Lab

Simulate and program Arduino and breadboard components.

Test your Arduino code in our real-time simulation environment and see your designs come to life in the browser.



<https://circuits.io/>



Blink



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()

Join a
HACKER SPACE

<https://wiki.hackerspaces.org/Hackerspaces>

RESOURCES

<http://www.allaboutcircuits.com/>

MAKE MAGAZINE

INSTRUCTABLES

ADAFRUIT TUTORIALS

DESIGN

VISIBILITY -

The interface must have visible features,
inferring the right messages to us

NATURAL SIGNALS

The natural or common understanding
of objects and their perceived use

NATURAL DESIGN

Design that leverages our understanding of the natural world



Battery

Ultra-thin rechargeable battery will last for several days on a charge.



Stabilizing Technology

Cutting-edge electronics will work to actively detect and stabilize your tremor.

Multiple Attachments

Fork, soup spoon, keyholder, and more are coming soon.



DESIGN MAPPINGS

Our link between
what you want to do
and what is perceived
possible

NATURAL MAPPINGS

takes advantage of physical analogies and cultural standards for immediate understanding



AFFORDANCE

the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used
(e.g. a chair affords sitting; glass affords seeing through, breaking; wood affords solidity, opacity, support, carving)



AFFORDANCE

The clue provider

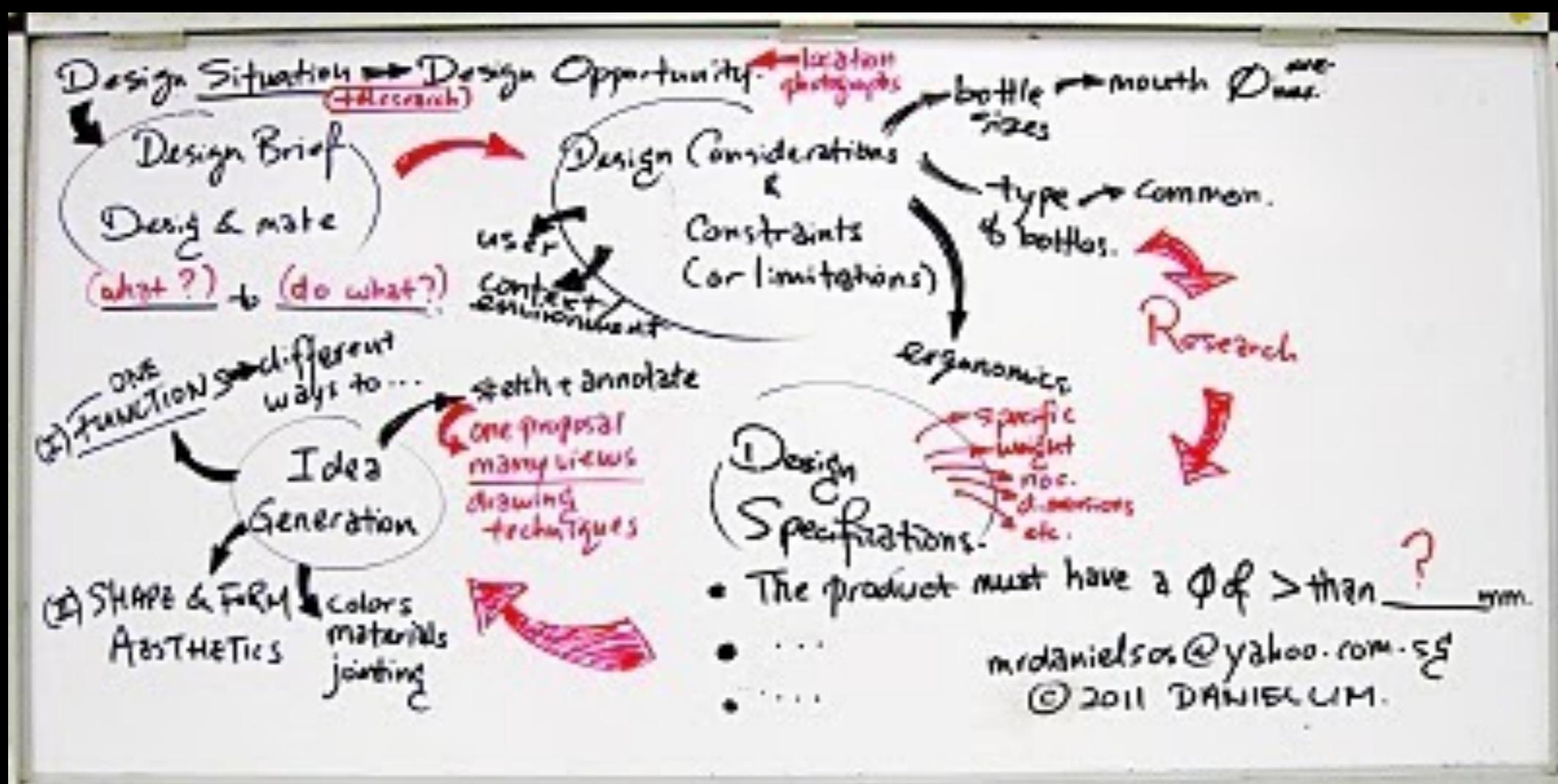


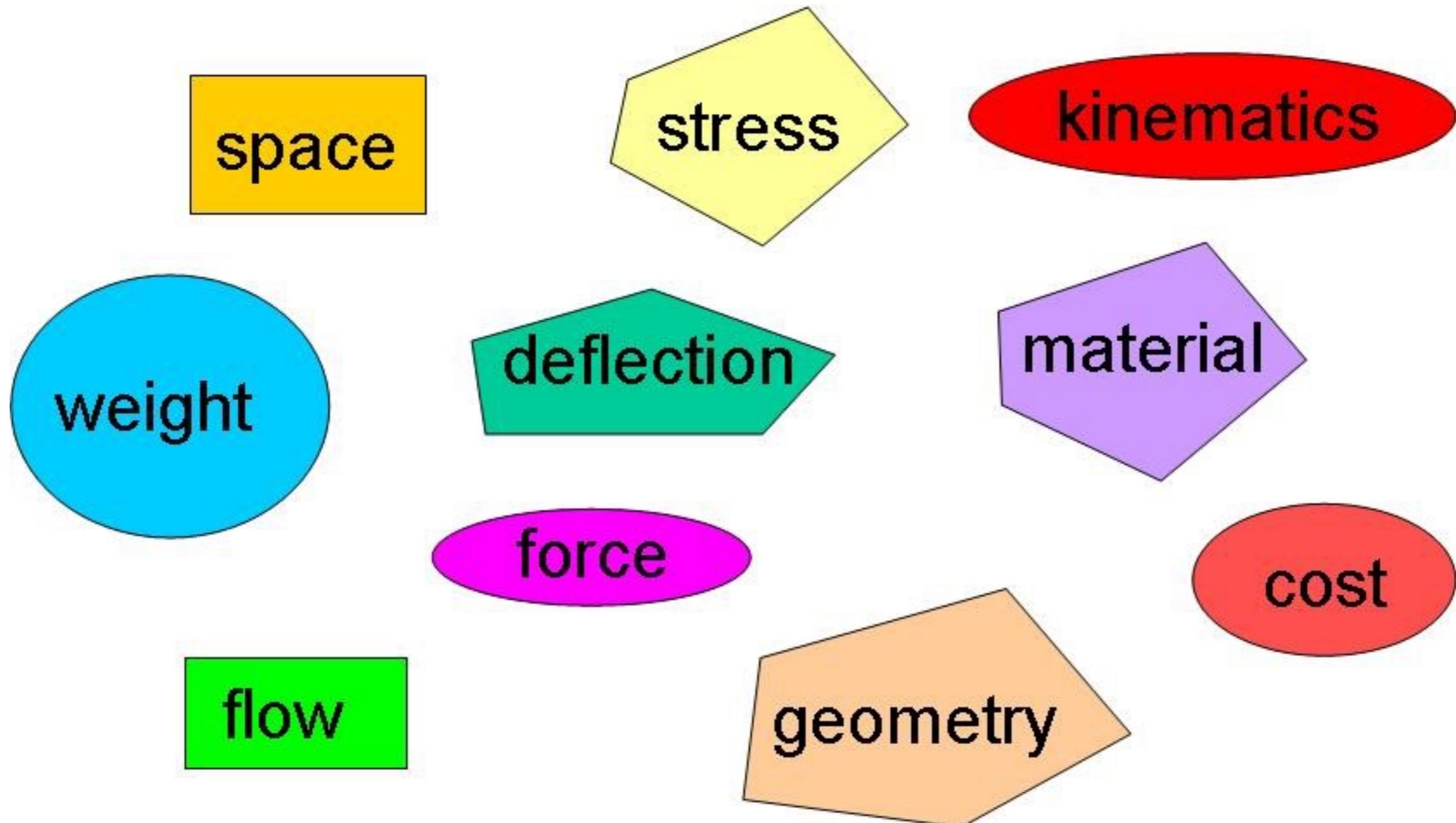
Constraints
limits to the perceived operation of a device

**“Design depends largely on
constraints”**

– Charles Eames







In every design attempt, there will be limitations or constraints or some form of hindrance. Some projects may be constrained by physical space or budget. Some limited by the choice of materials. And most with a time constraint.

Conceptual Model

The designer's mental simulation of a device's operation.

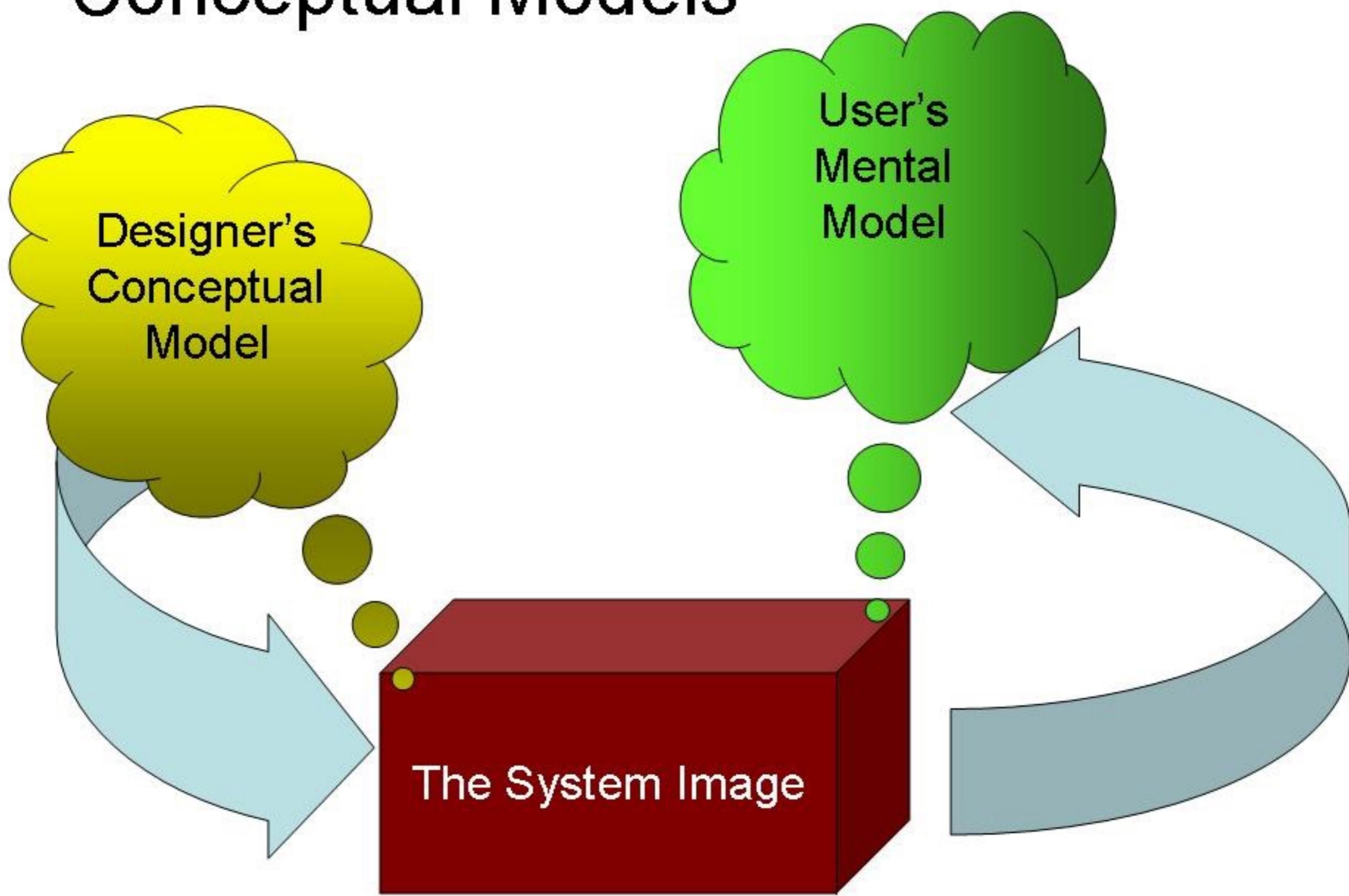
These can be based on MAPPINGS,
AFFORDANCES and
CONSTRAINTS.

What are mental models?

“Models people have of themselves, others, their environment, and the things they interact with”



Conceptual Models



SYSTEM IMAGE

System Image – the visible part of the device being used. If incomplete / contradictory, the user cannot easily use the device.





FEEDBACK

sending information back to the user
about what action has actually been
done and what result was
accomplished