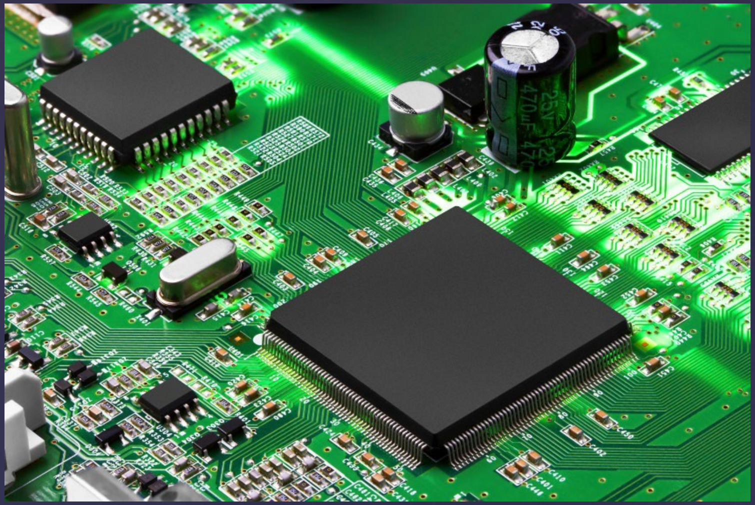
Introduction to Electronics

Numbers / Scale / Units

Tom Thoen – Teacher / Student / Hobbyist / Inventor

What does “*Electronics*” Mean?

When you hear this word, what do you think of???



e·lec·tron·ics

noun

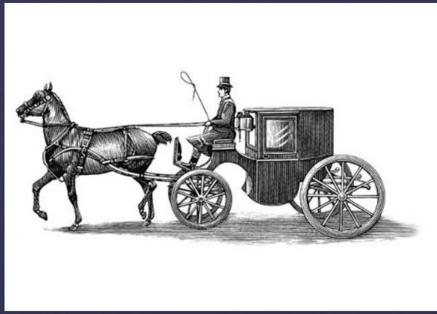
1.the branch of physics and technology concerned with the **design of circuits** using transistors and microchips, and with the **behavior and movement of electrons** in a semiconductor, conductor, vacuum, or gas.

Why is it important to understand electronics???

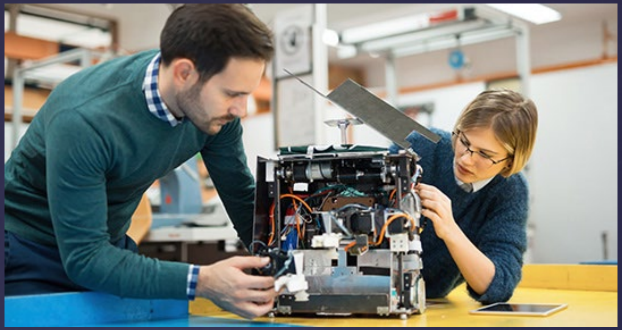
Few “things” affect our live as much as electronics do….list as many devices you own or use that are electronic…

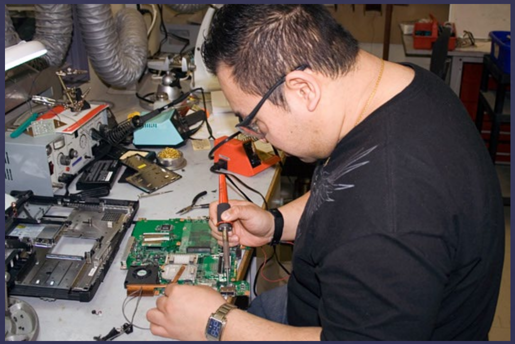
Impacts on Society

What would our world be like without electronics or electricity?

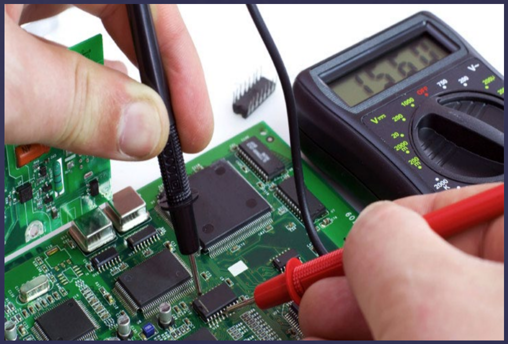


Jobs in electronics

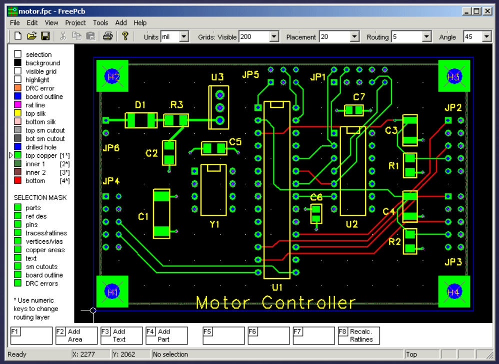




Electronic Assemblers
Fabrication and Assembly



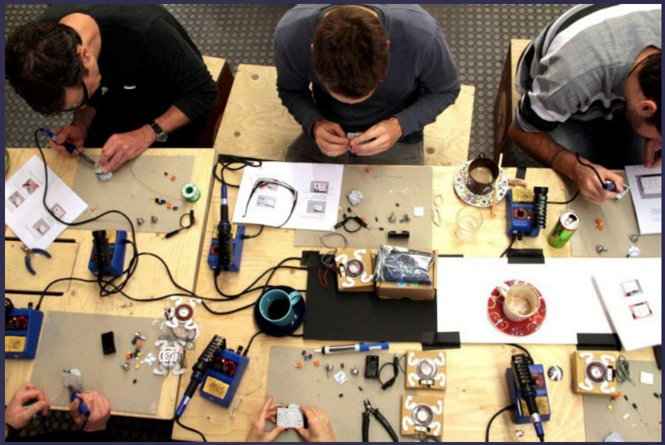
Electronic Technicians
Repair / Troubleshooting



Technologists
Routine Design / CAD / Manufacturing support

Jobs in electronics

Electronic Engineers
System Design / Analysis



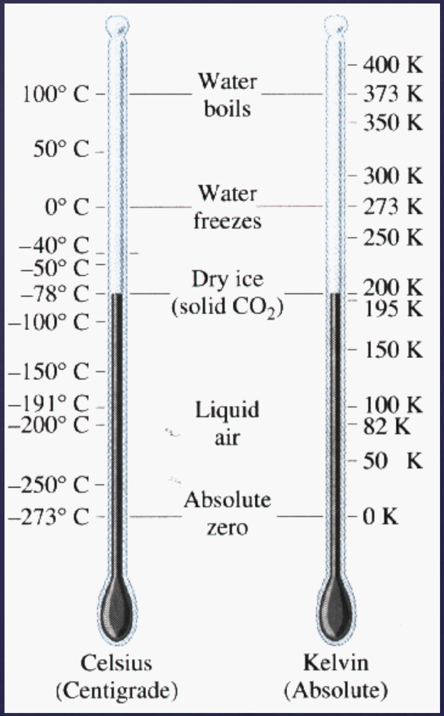
Also there are “makers”

This class is a <u>survey</u> class: Many topics are covered over a short period of time

- Even though physics based, we won't be spending much time on physics.
- However, basic math is critical to understanding circuits.

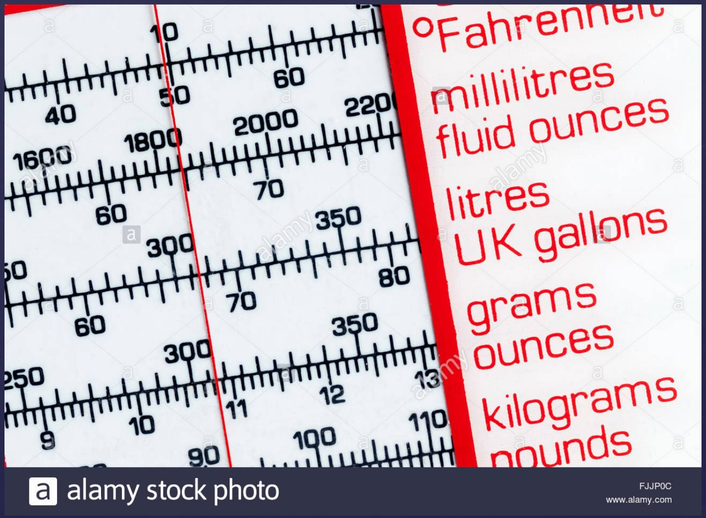
To understand electronics we need to work with *Numbers, Scale* and *Units* –

- Numbers – fairly obvious.
- Scale – size of numbers.
- Units – standard quantity of values.

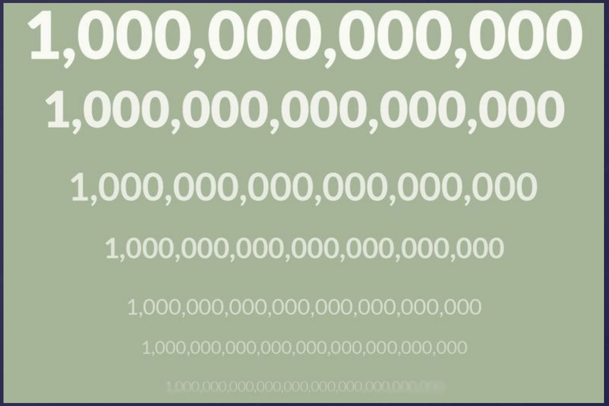


Scale or *magnitude* determines the range of numbers
- Example of small scales…

- Age – 1 to 90ish
- Money in your wallet - $0 to $50
- Temperature in California, 35°F to 120°F



Scale or *magnitude* - Large values…



- Number of people on the planet:
  - 7.1 Billion = 7,700,000,000 People*
- The U.S. national debt:
  - $23.3 Trillion = 23,300,000,000
- Power consumed by the U.S.
  - 4,686,400,000 MW h/y = 4,686,400,000,000,000 Watt hours / year

https://www.worldometers.info/world-population/
https://www.usdebtclock.org/

- Large *scales* of Small *values*…

- Thickness of a pencil lead
  - 0.5mm = ~0.02 inches
- Thickness of a piece of paper
  - .1mm = ~0.0039 inches
- Weight of an ant
  - 1 – 5mg = ~.0000022 Pounds (2.2 x 10^{-6} Pounds)
- Time it takes for light to travel one mile
  - .000005368 seconds 5.368 microseconds (5.368 x 10^{-6} seconds)

Units are the basis of the scale we are measuring.

"A quantity chosen as a standard in terms of which other quantities may be expressed."

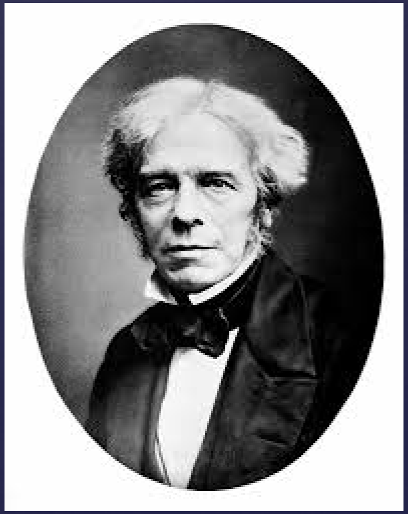
- From the previous examples:

Quantity	*Units*
0.02	inches
1 – 5	milligrams (mg)
.0000022	Pounds
5.368	microseconds

- Units continued

In Electronics we use specific units often based on the names of the individuals who discovered or researched each phenomenon:

- Common electronic units:
  - *Units* Abbreviation
  - Volts V
  - Ohms Ω
  - Amps A
  - Farads F
  - Henries H



Why do we care???

- Electronics measurements are often *very small or very large,* and we need to write these numbers in a way that makes sense.

Scientific Notation / Powers of 10 or "orders of magnitude" use *exponents* to express numbers in a more compact method, **reducing errors and making it easier to perform calculations**

- Each "exponent" increases the value by a factor of 10
- The weird one is 0…
  - $10^0 = 1$
  - $10^1 = 10$
  - $10^2 = 100$
  - $10^3 = 1000$
- So, instead of writing 3,000 we can write this number as 3×10^3

Powers of 10 cont'd…

- We can also use exponents to represent any decimal values…
- $3{,}250 = 3.25 \times 10^3$
- $1{,}445{,}000 = 1.445 \times 10^6$
- *Note that with positive exponents we always move the decimal point of the original number to the left.*

Powers of 10 cont'd…

- How about small numbers??
- $10^{-1} = .1$
- $10^{-2} = .01$
- $10^{-3} = .001$

- Example: 0.450 = 450×10^{-3}
- $0.003 = 3 \times 10^{-3}$
- $0.000027 = 27 \times 10^{-6}$

- *Note that with negative exponents we always move the decimal point of the original number to the right.*

Engineering Units

- In engineering we tend to use exponents in powers of 3, along with specific prefixes – we will discuss this more later, but…

A basic example:

$1000 = 1 \times 10^3$

But, instead of writing the exponent with a '3' we can instead use the letter "k" which stands for kilo, or 1000. So, we can write this as:

1K

Accuracy…

- In electronics we are usually not concerned with accuracy of more than 1-2%. Why? Most electronic components have a tolerance greater than this value. Also, the measurement tools may not be that accurate

- Accuracy: *the degree to which the result of a measurement, calculation, or specification conforms to the correct value or a standard.*
- Usually represented in % or +/- %

- *Repeatability…*
  How close in value measurements occur – we want to be able to repeat the same experiment with the same results…

- Repeatability: *the variation in measurements taken by a single person or instrument on the same item, under the same conditions, and in a short period of time.*

Ideal Values and Significant figures…

Ideal values are the "perfect" value given for a circuit. For example, if a battery is listed as a 9 volt battery, it means it's value is 9.000000000 volts. Not realistic, but used to determine the theoretical value.

Significant figures are used to represent the reasonable representation of a calculation. With ideal values, there would be an limited number of significant figures. For example, 32.7 volts

In the real world, we are limited by the accuracy of the measurement, so we limit the number of significant figures.