STEAM CLOWN™ PRODUCTIONS

CAPACITORS

STEAM CLOWN™ & Squeaky Hinge PRODUCTIONS

STEAM CLOWN™ PRODUCTIONS

SEE APPENDIX A, FOR LICENSING & ATTRIBUTION INFORMATION

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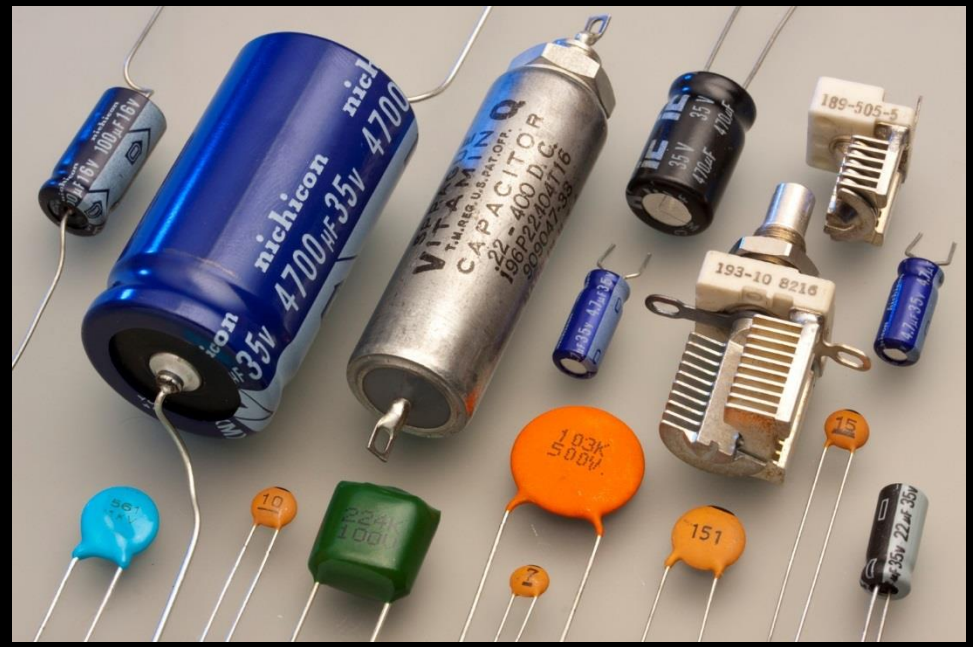
WHAT YOU WILL KNOW…

- Prior Knowledge
  - How a Bread Board Works
  - How to Use a DMM to measure voltage

- What You Will Be Able To Do Or Know
  - Calculate for Time in and Resistor/Capacitor network
  - Build a R/C circuit and measure the time to charge/discharge
  - Be able to describe how an R/C circuit works

Capacitors - Introduction

- A capacitor is a two-terminal, electrical component that can **store** and **hold** energy
- It is a **passive** components
  - Fundamental, like Resistors & Inductors
  - Almost all circuits have a capacitor in it.



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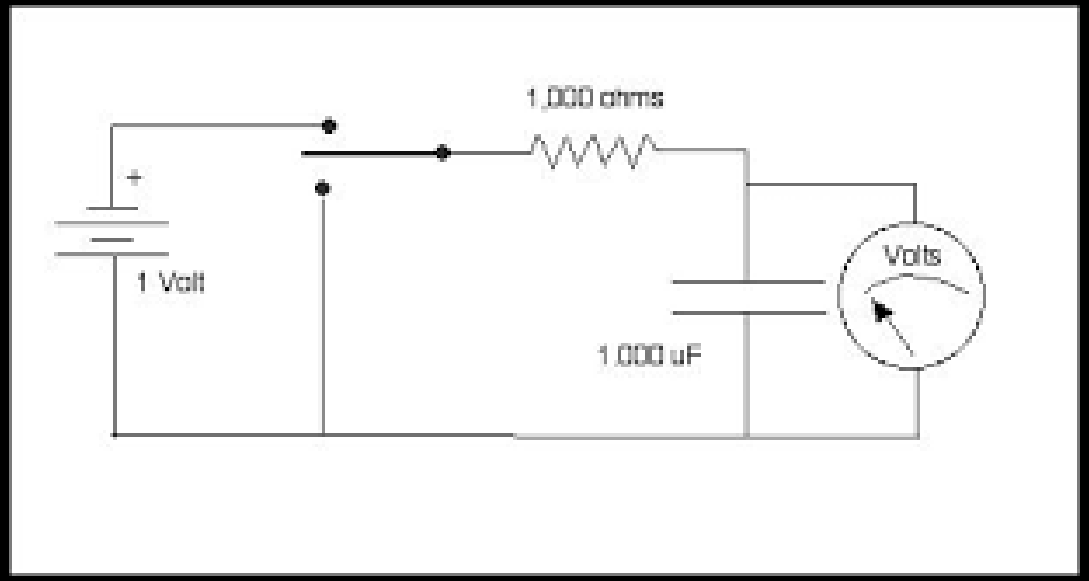
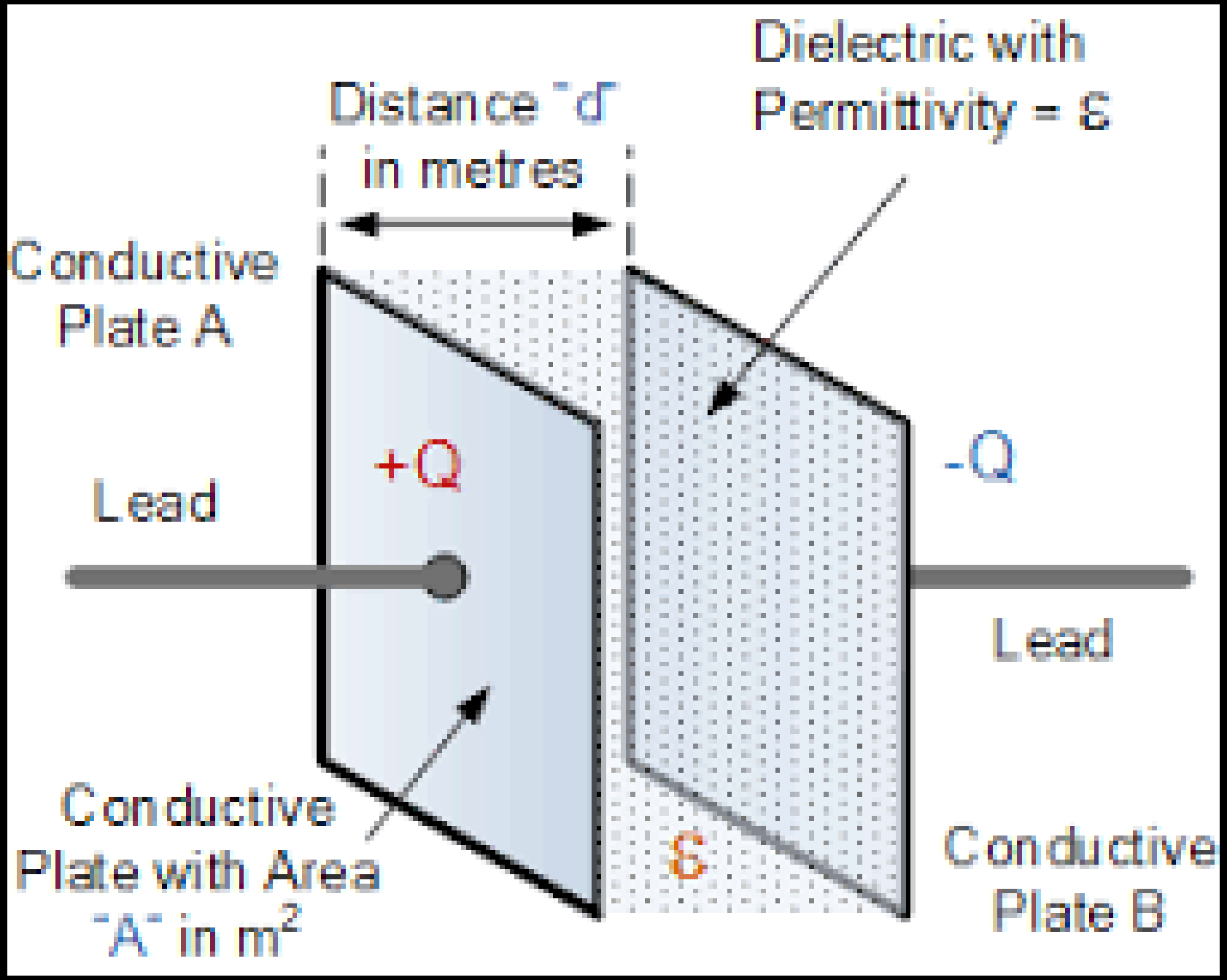
Like a little battery…

- Capacitors have the ability to **store energy**
  - Like a fully charged electric battery
- Common applications include:
  - Local energy storage
  - Voltage spike suppression
  - Complex signal filtering.





- https://electronics.stackexchange.com/questions/18301/how-does-a-capacitor-block-dc

- https://learn.sparkfun.com/tutorials/capacitors

Capacitance - Farads

- The unit of capacitance is F (Farads)
- A capacitor has a capacitance of 1 farad if a charge of 1 coulomb increases the potential difference between its plates by 1 volt
- The farad is coulomb⁄volt
- The farad is much too big for most practical purposes; microfarads, nanofarads, and picofarads are usually used.

READING CAPACITORS

- $1\mu F = 1^{-6}$ Farads
- 1µF = .000001 Farads
- 1000000µF = 1 Farads

Microfarad [µF]	Farad [F]
0.01 µF	1.0E-8 F
0.1 µF	1.0E-7 F
1 µF	1.0E-6 F
2 µF	2.0E-6 F
3 µF	3.0E-6 F
5 µF	5.0E-6 F
10 µF	1.0E-5 F
20 µF	2.0E-5 F
50 µF	5.0E-5 F
100 µF	0.0001 F
1000 µF	0.001 F

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TIME CONSTANT T=RC

- t = RC
  - Where R is Ohms and C is FARADS

µF	Farads
100µF	.0001F
10µF	.00001F
1µF	.000001F
.1µF	.0000001F
.01µF	.00000001F
.001µF	.000000001F

- You need to convert any µF to F… so just move the decimal point to the left 6 places

TIME CONSTANT T=RC

- t = RC
  - Where R is Ohms and C is FARADS

µF	Farads
100µF	.0001F
10µF	.00001F
1µF	.000001F
.1µF	.0000001F
.01µF	.00000001F
.001µF	.000000001F

t=RC

t = 100µF x 100KΩ

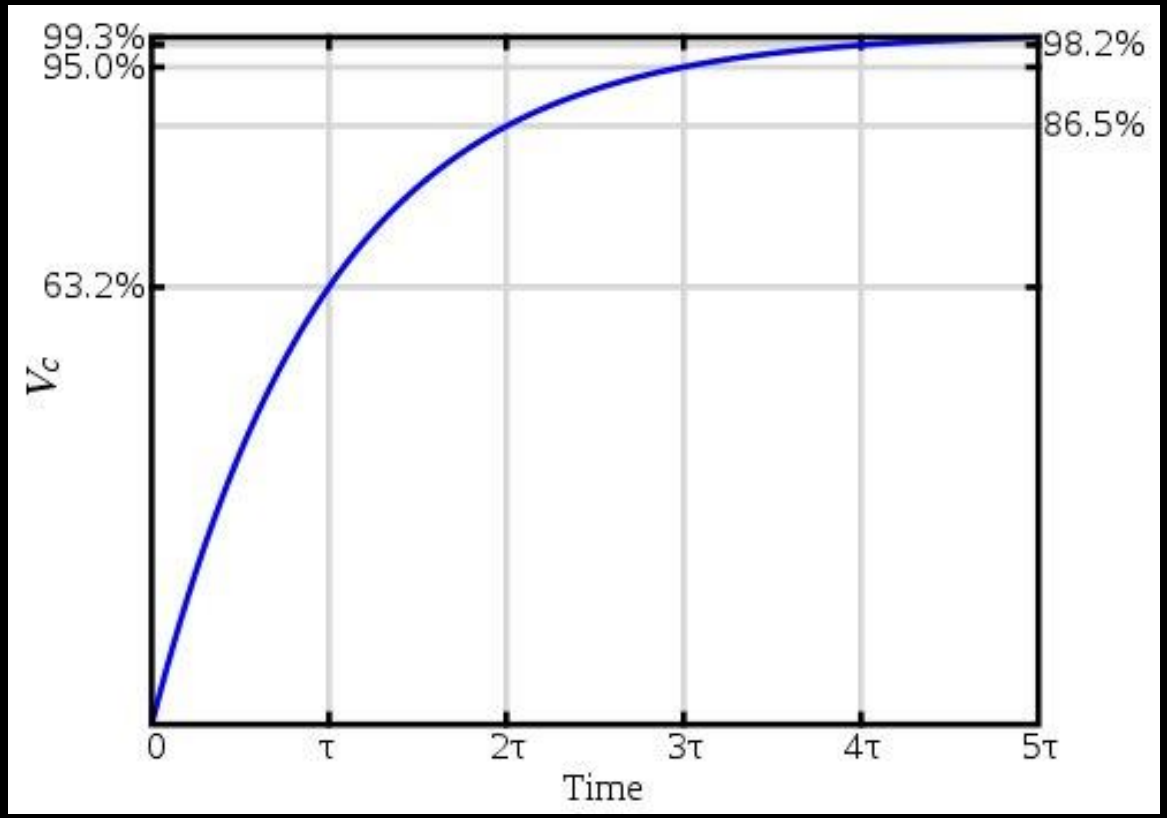
t = .0001F x 100KΩ

t = 10 seconds

THE TIME CONSTANT...

- is the time taken (in seconds) by the capacitor C that is fed from a resistor R to charge to a certain level.
- The capacitor will charge to 63% of the final voltage in one time constant
- 85% in two time constants
- 100% in five time constants.

If you graphed the % charge against time constant, the result is exponential. That is:



ALGEBRA... SOLVE FOR C AND R

$$t = RC$$

$$\frac{t}{R} = \frac{RC}{R}$$

$$\frac{t}{R} = C$$

$$C = \frac{t}{R}$$

$$t = RC$$

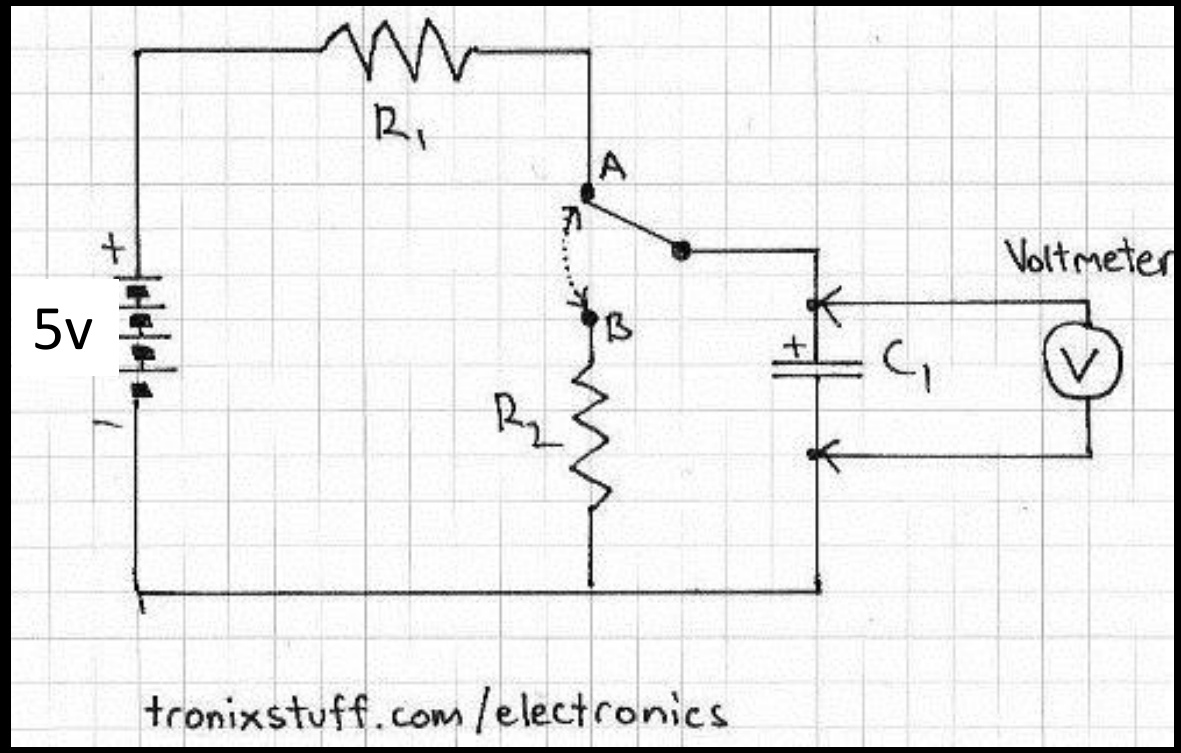
$$\frac{t}{C} = \frac{RC}{C}$$

$$\frac{t}{C} = R$$

$$R = \frac{t}{C}$$

Check your math to the real world...

- Pick a C_1 and a Time Constant for R_1 and another Time Constant for R_2
- Calculate R_1 and R_2
- Build it, and measure your Time Constants



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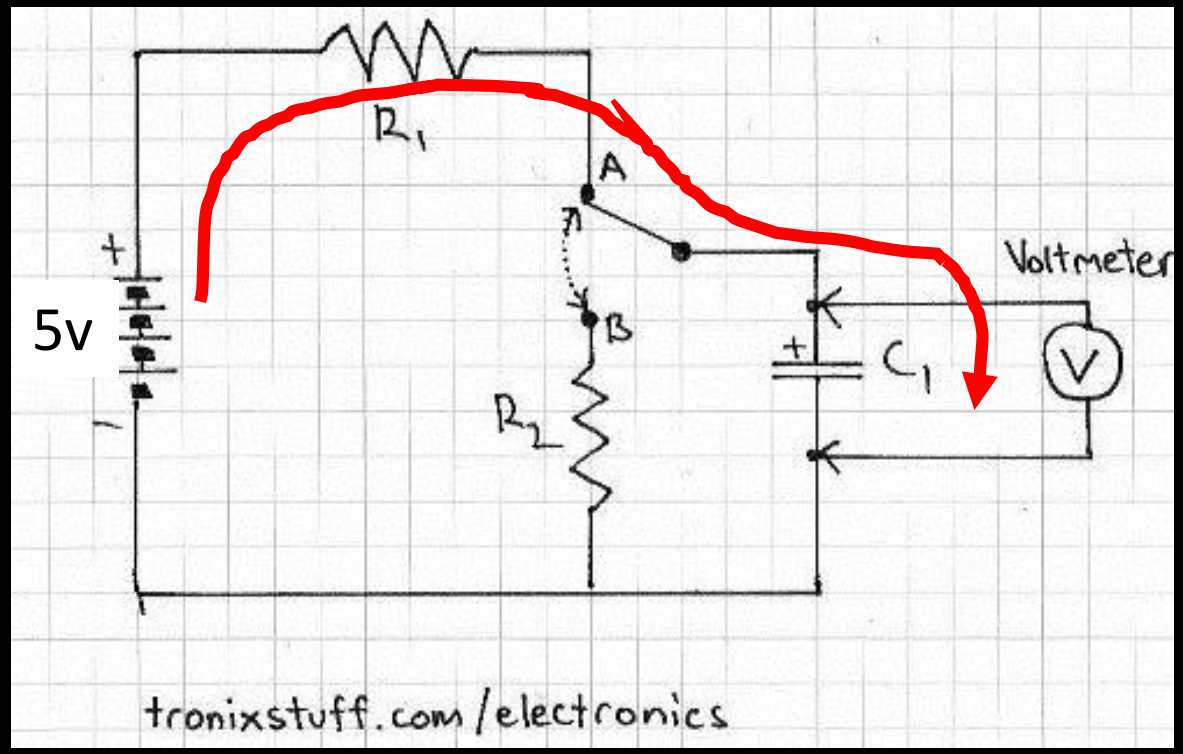
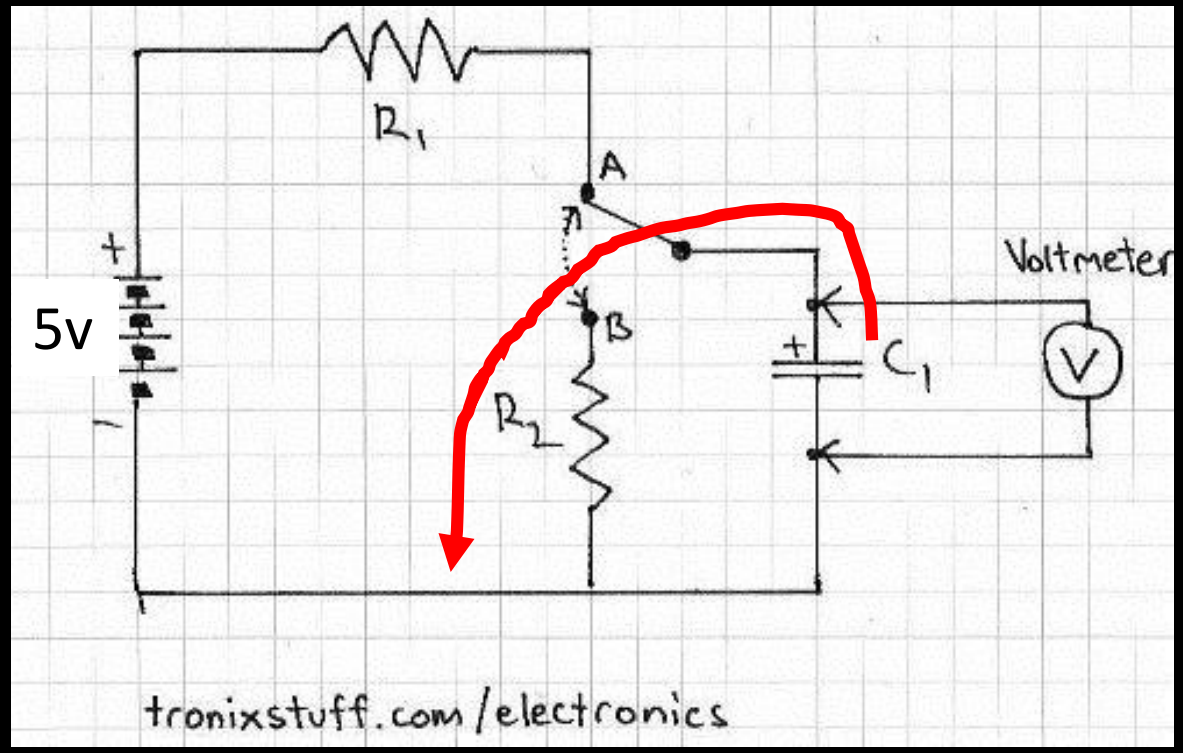
Check your math to the real world...

- Pick a C_1 - could be the same 100µF cap
- Pick a Time Constant for R_1
- Calculate $R_1 = t/C$
- Build it, and measure your Time Constants



Check your math to the real world...

- Pick a C_1 - could be the same 100µF cap
- Pick a Time Constant for R_2
- Calculate $R_2 = t/C$
- Build it, and measure your Time Constants



APPENDIX

Appendix A: License & Attribution

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- My best attempt to properly attribute, or reference any other sources or work I have used are listed in Appendix B

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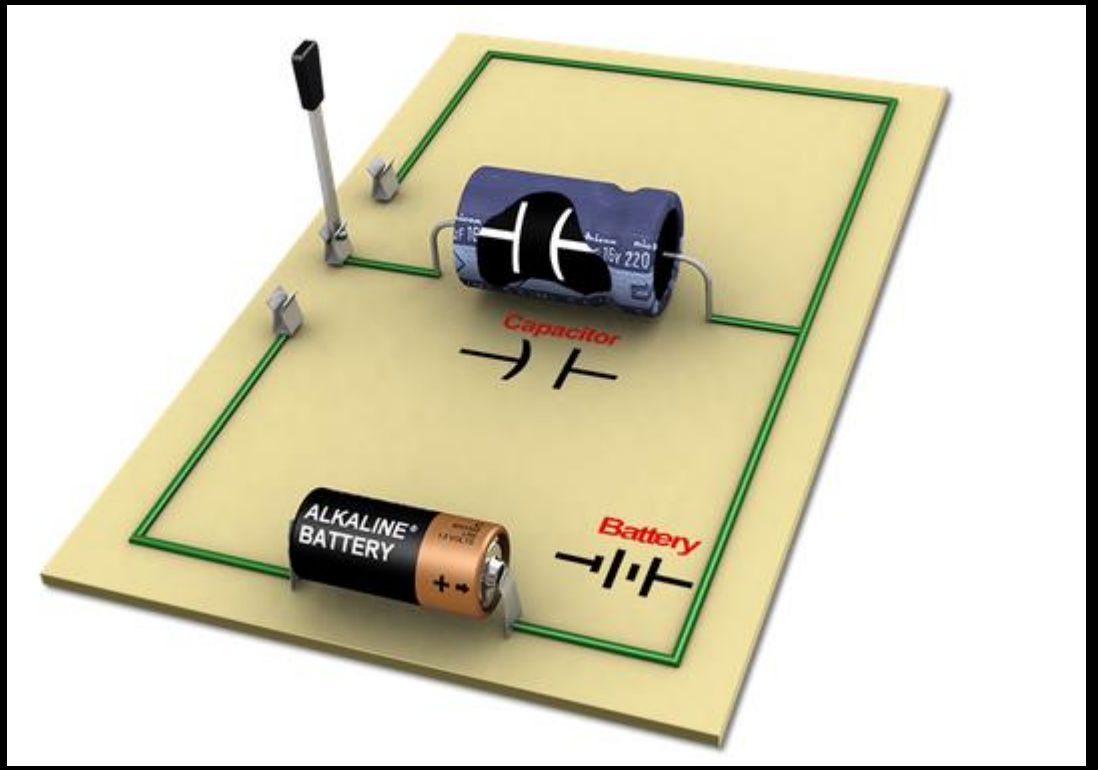
Appendix B: Attribution for Sources Used

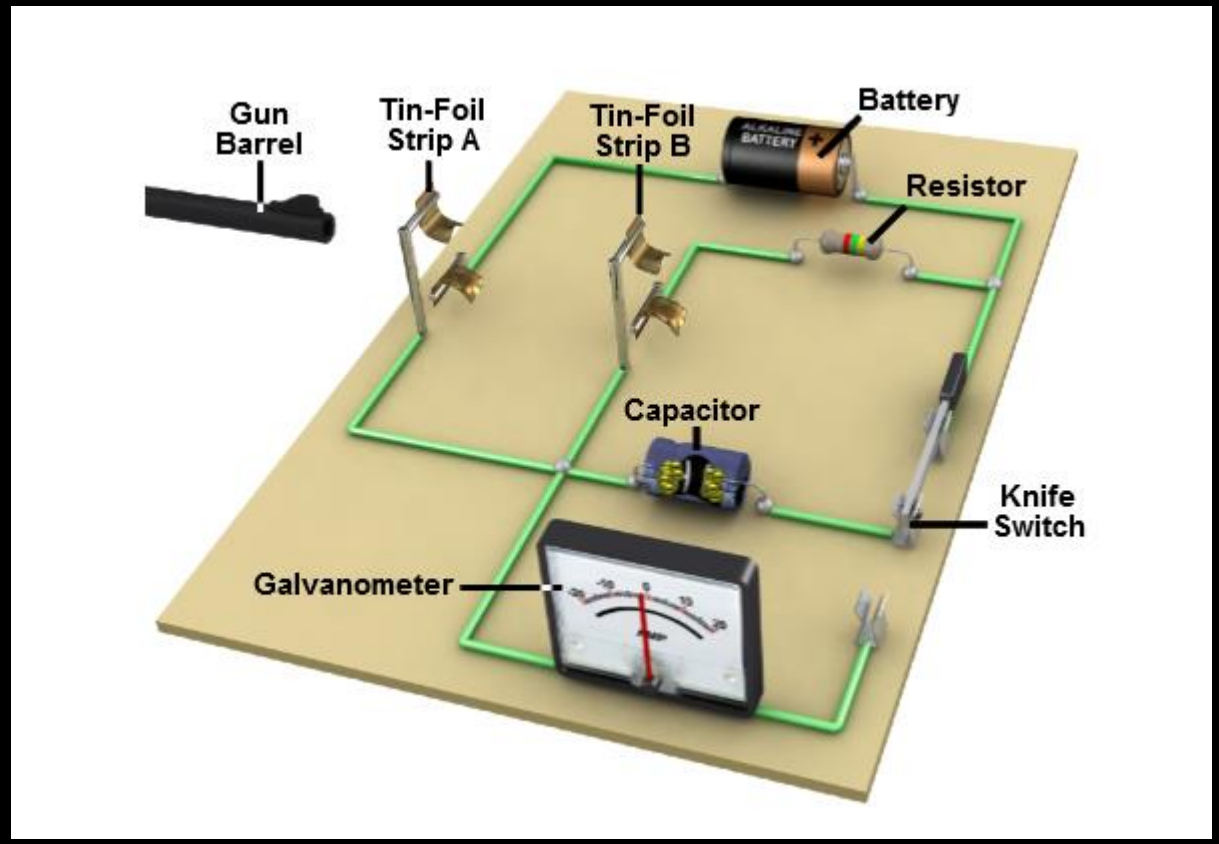
- SparkFun – Capacitors
  - https://learn.sparkfun.com/tutorials/capacitors
- Tronixstuff
  - https://tronixstuff.com/2010/06/11/education-the-rc-circuit-2/

REFERENCE SLIDES

- SS



http://micro.magnet.fsu.edu/electromag/java/capacitor/index.html



https://nationalmaglab.org/education/magnet-academy/watch-play/interactive/bullet-speed