EECS 16A

Spring 2023 - Profs. Muller & Waller

Lecture 8A - Capacitors

Admin

Midterm scores have been released
Overall – great work!

Mean: 72.55
Median: 76.1
Standard Deviation: 17.92

Toolbox

KVL: Voltage drops around a loop sum to 0

KCL: All currents coming out of a node sum to 0

$V = IR$

$P = IV$

$$R = \frac{\rho L}{A}$$

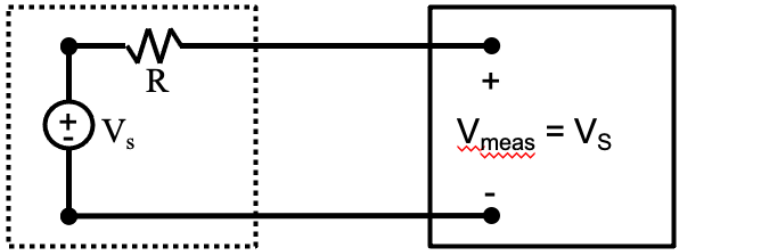
V_{source}(off) → short

I_{source}(off) → open

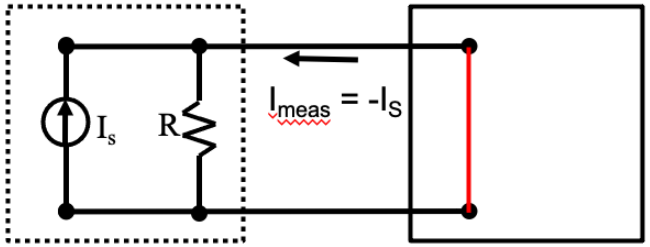
$$R_1 \parallel R_2 = \frac{R_1 R_2}{R_1 + R_2}$$

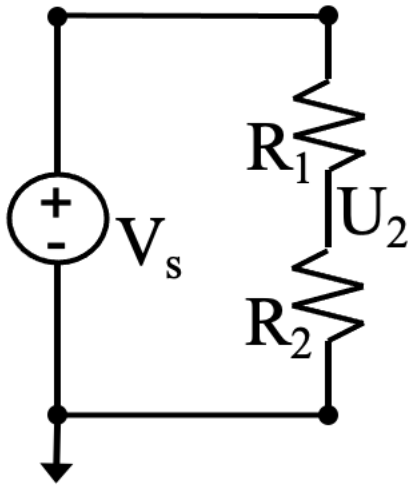
$$R_{Th} = V_{Th}/I_N$$

V Measurement Circuit



I Measurement Circuit

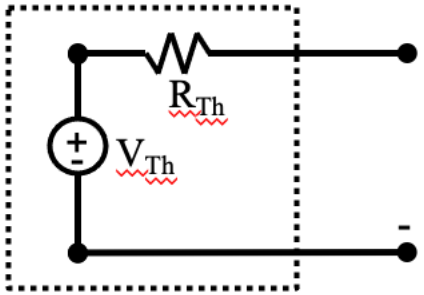




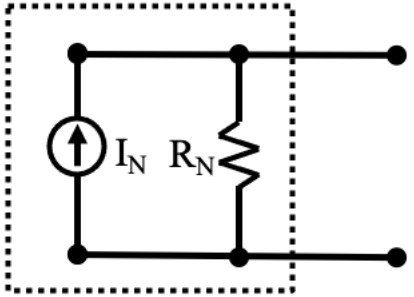
$$I = \frac{V_S}{R_1 + R_2}$$

$$U_2 = \frac{V_S R_2}{R_1 + R_2}$$

Thevenin Equivalent Circuit



Norton Equivalent Circuit

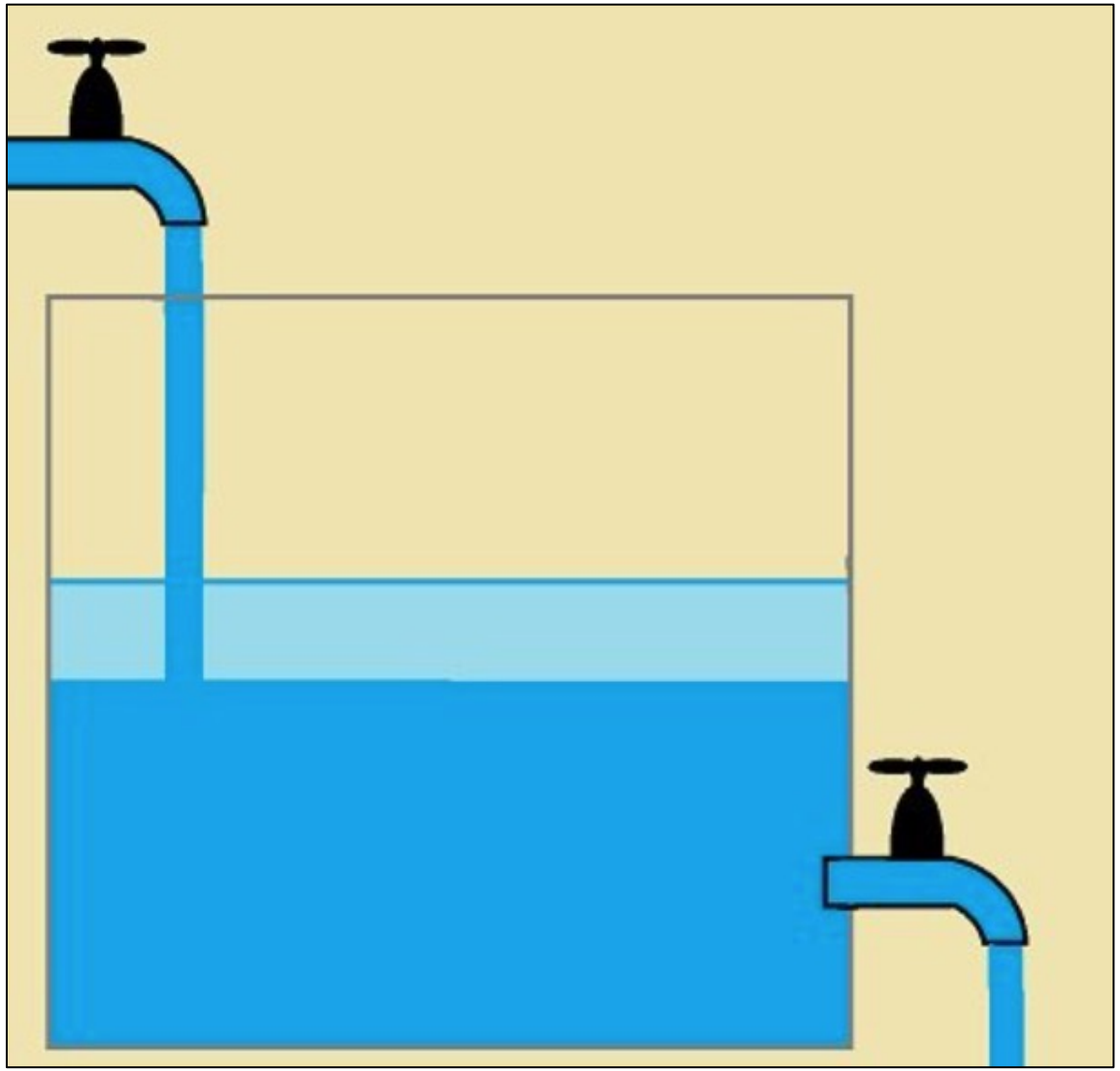


What is a Capacitor?

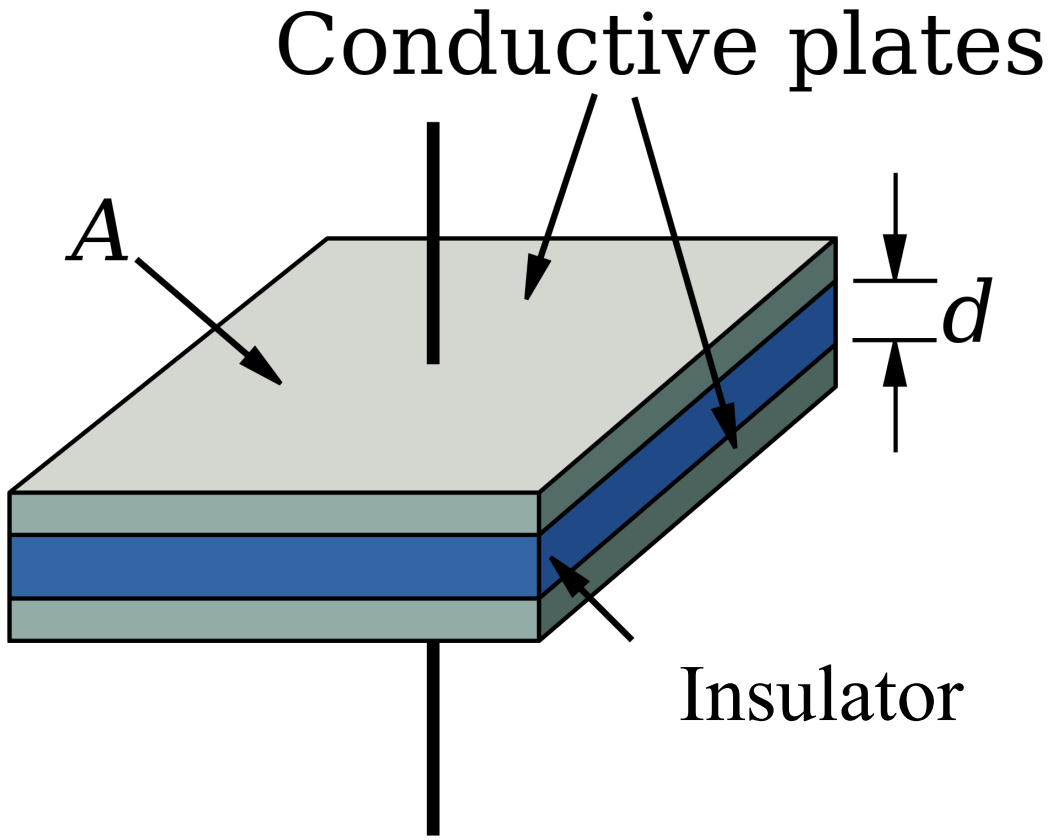
Stores Electric Charge

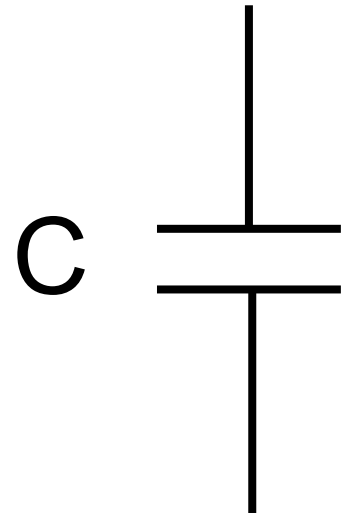
	Capacitor	**Battery**
Storage	Less	More
Charge/discharge	Fast	Slow

Water Analogy!

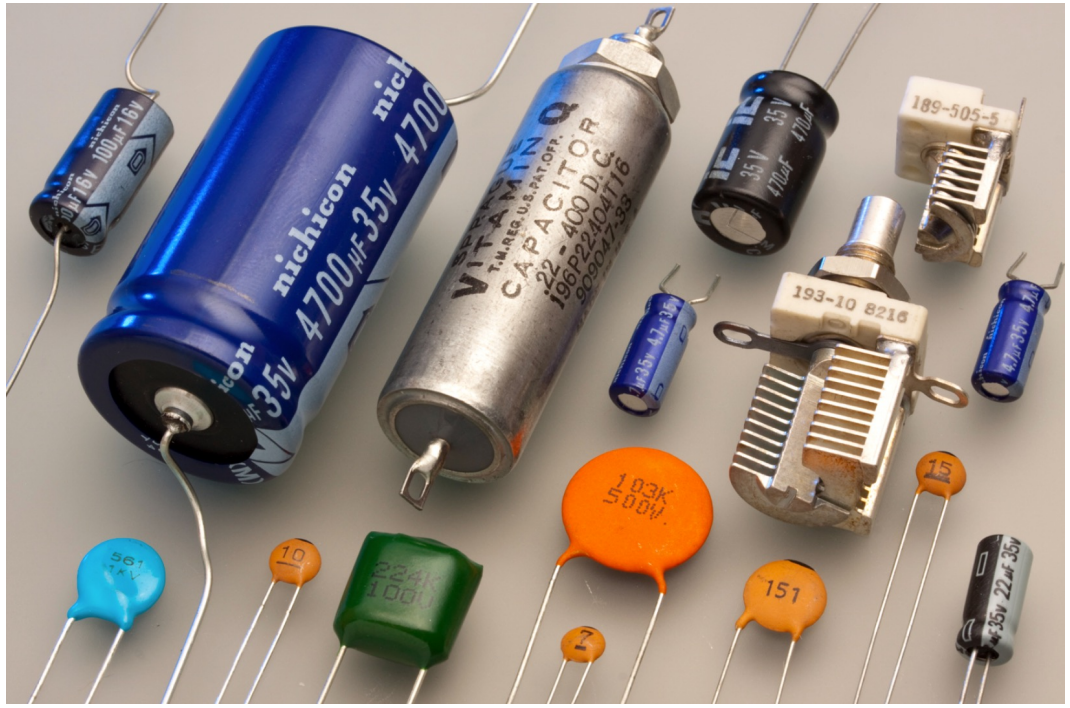


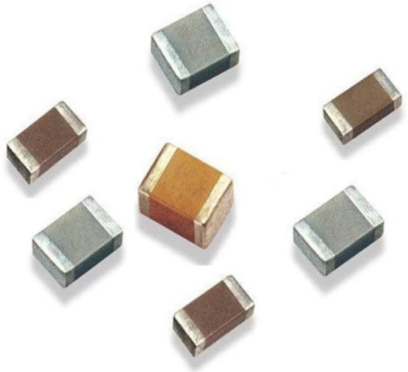
Capacitors

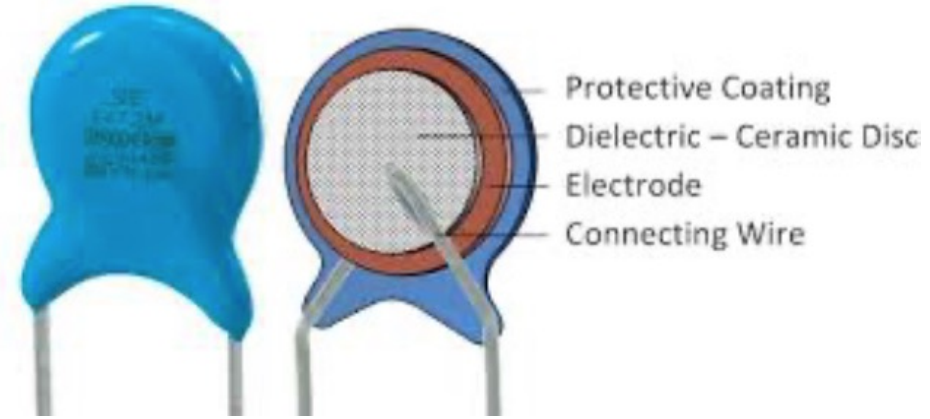


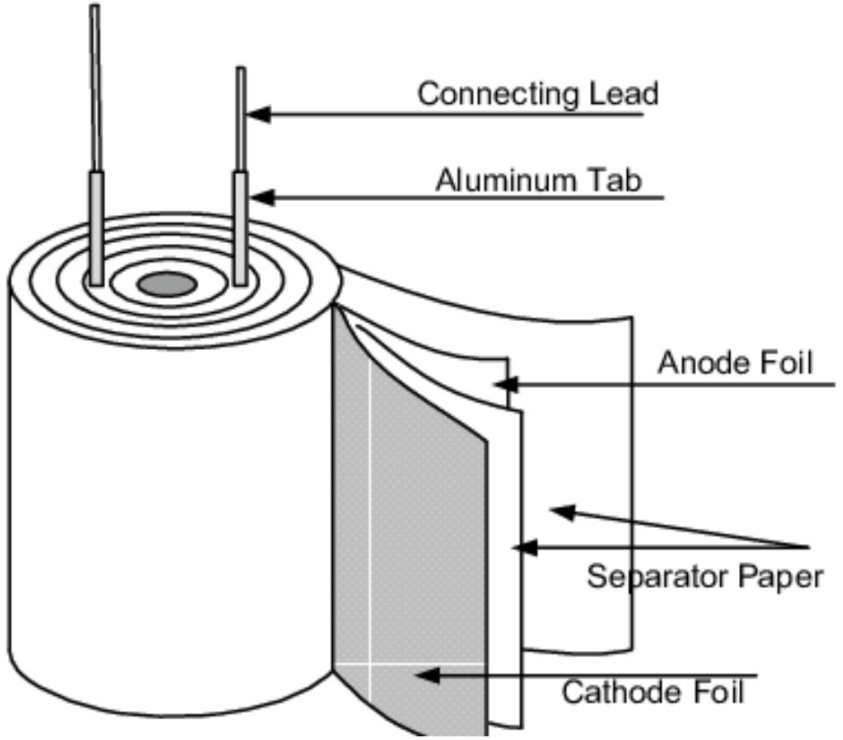


Real Capacitors

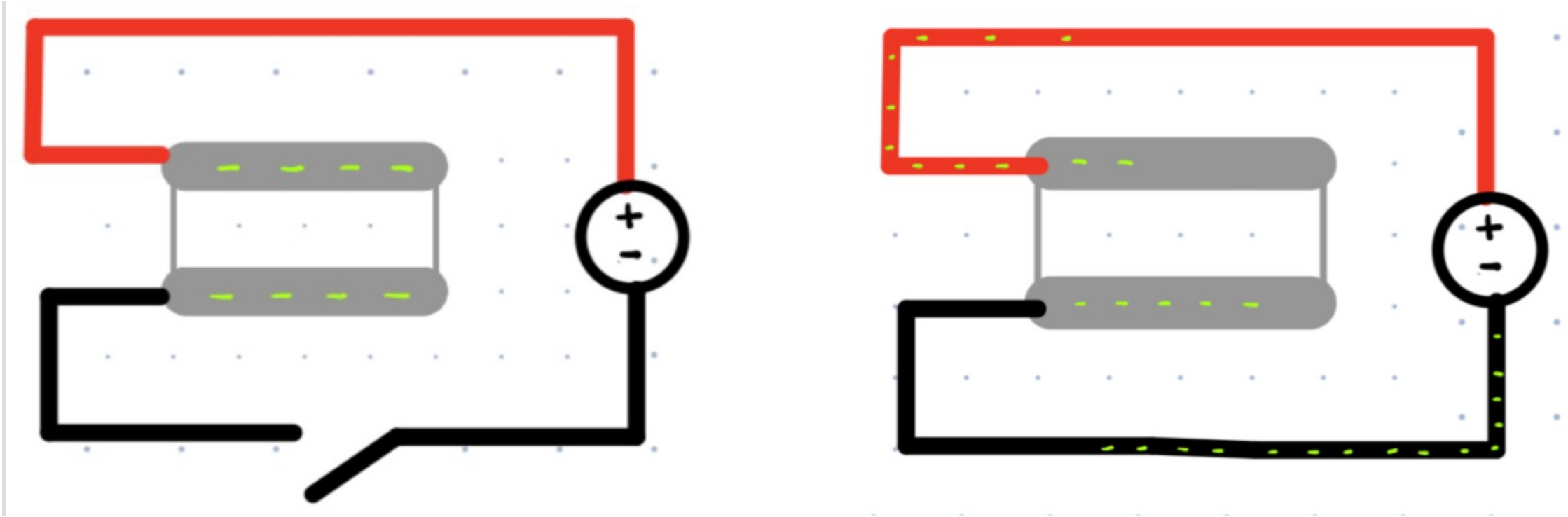








Physics of Capacitors



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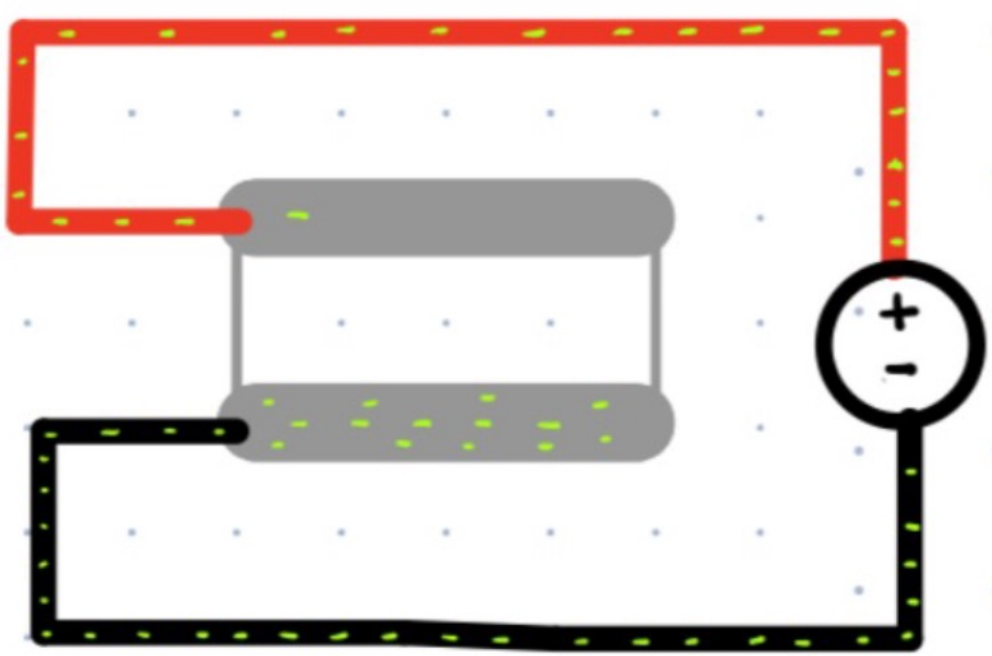
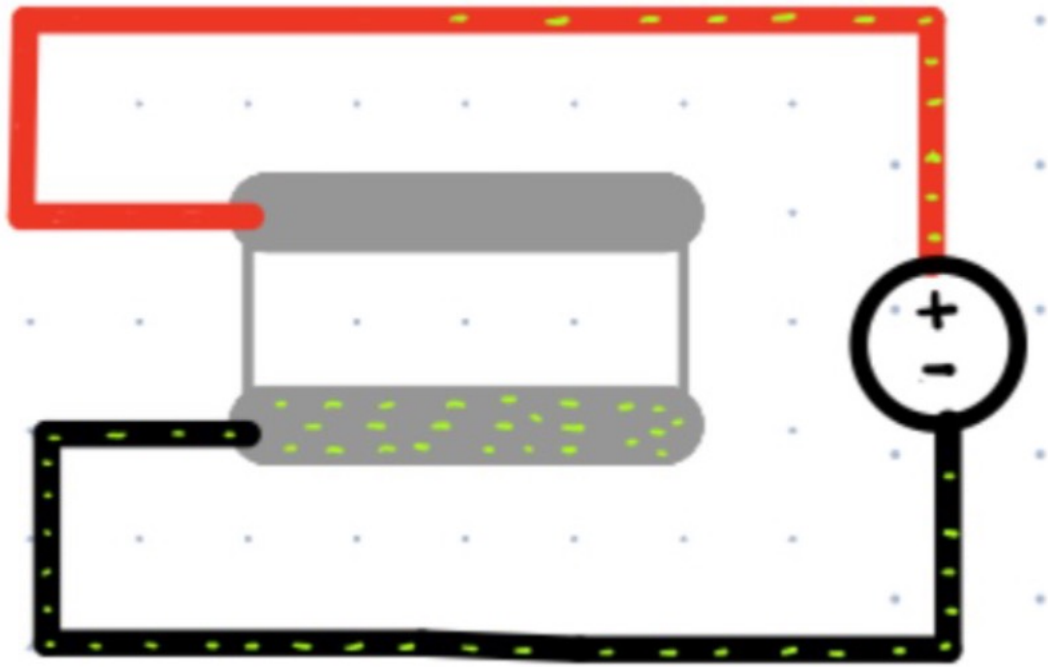
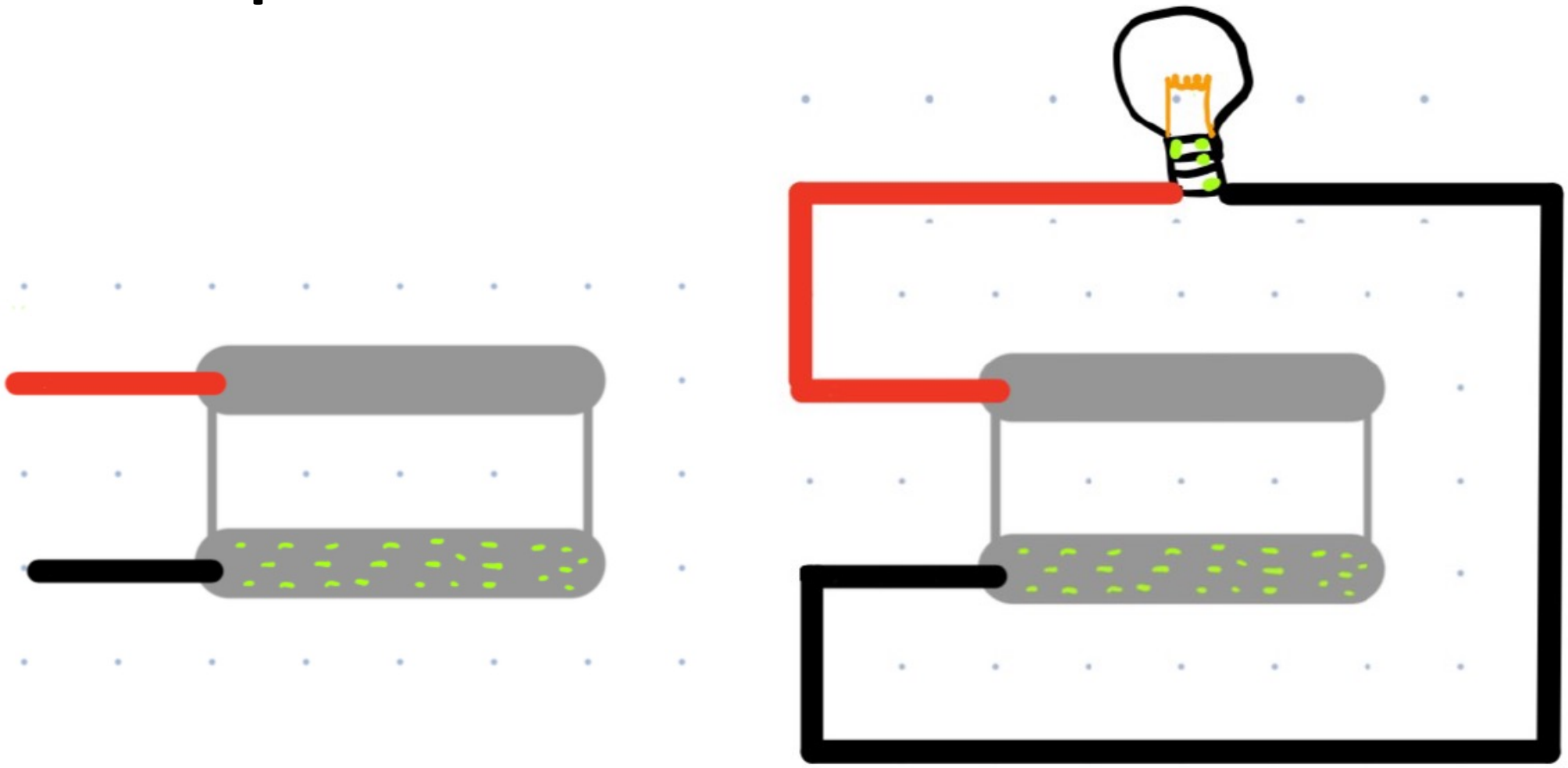
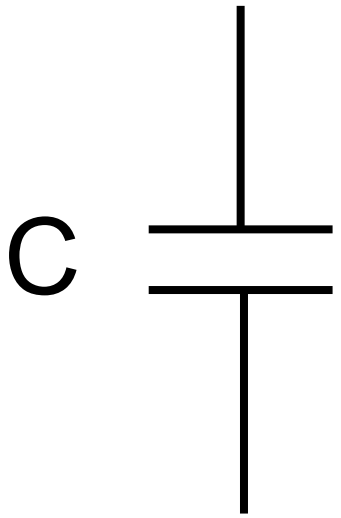




Physics of Capacitors



Circuit Model



Capacitance C in [Farads] or [F]

$$Q_{elem} = C\ V_{elem}$$

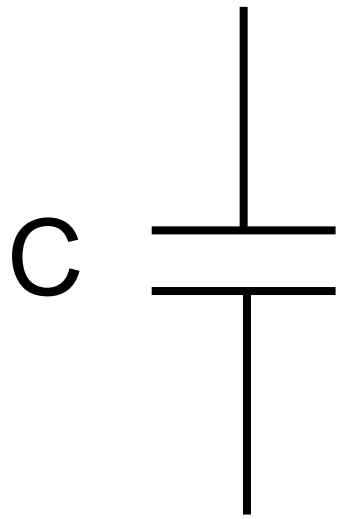
Recall: $I_{elem} = dQ_{elem}/dt$

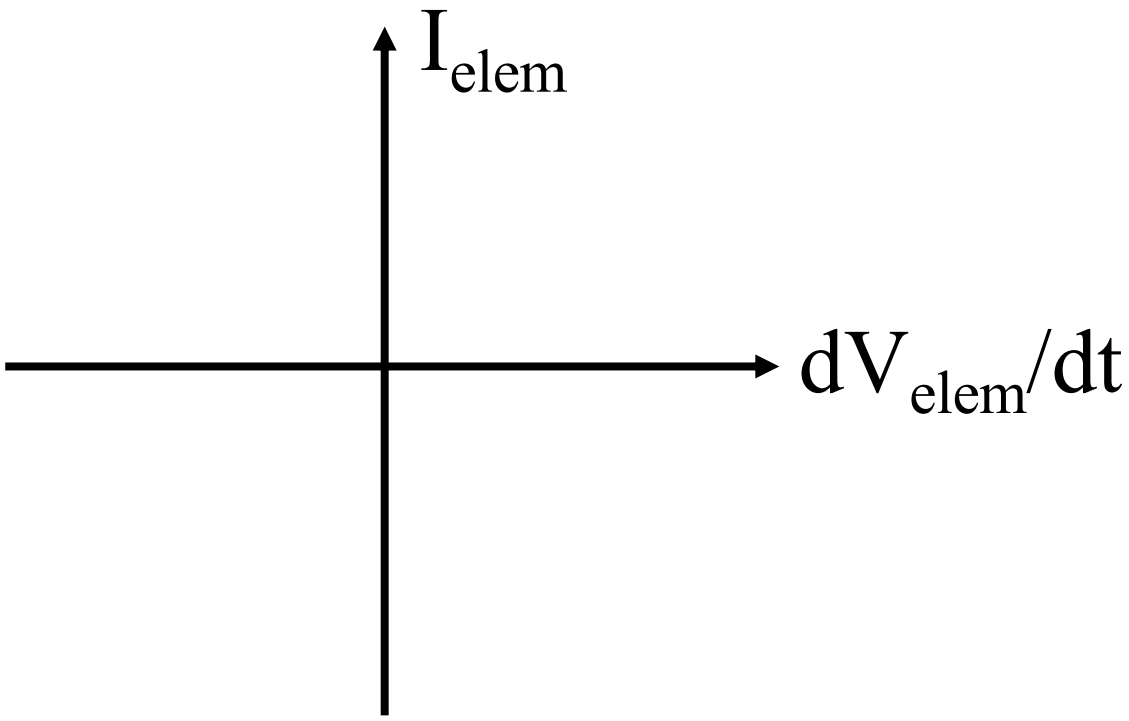
$$dQ_{elem}/dt = C\ dV_{elem}/dt$$

$$I_{elem} = C\ dV_{elem}/dt$$

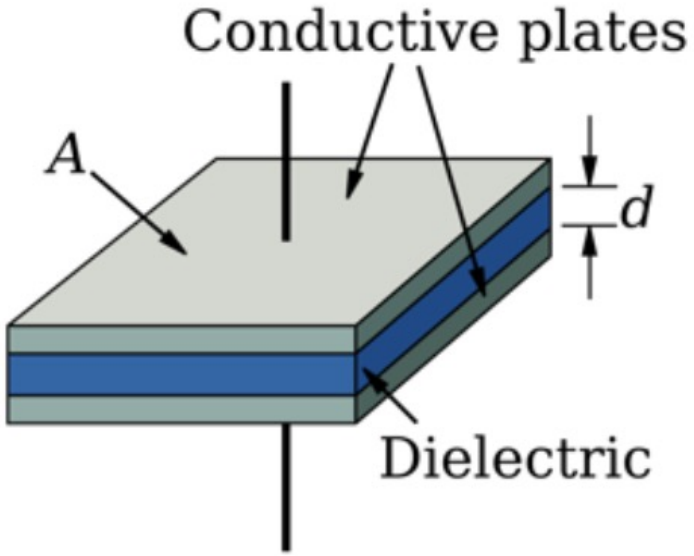
Circuit Model

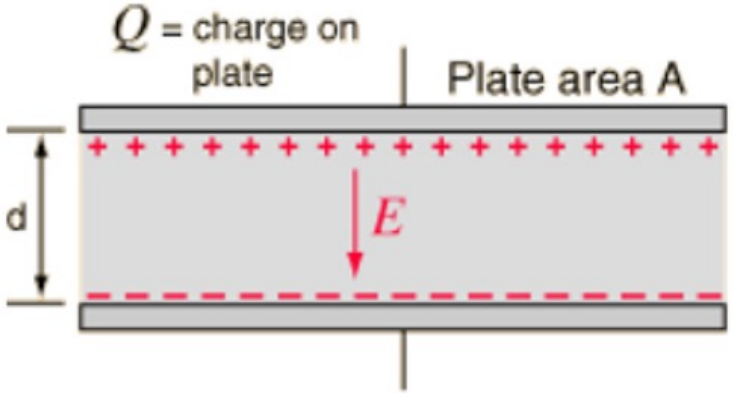
$$I_{elem} = C\ dV_{elem}/dt$$





But Seriously….What is Capacitance?

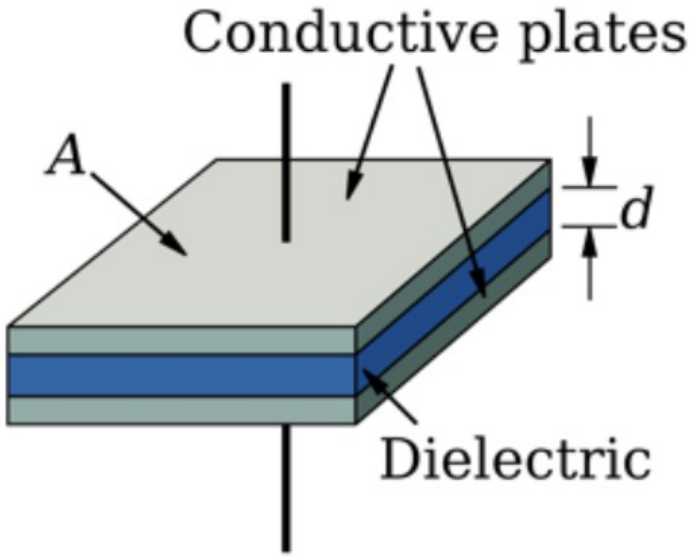


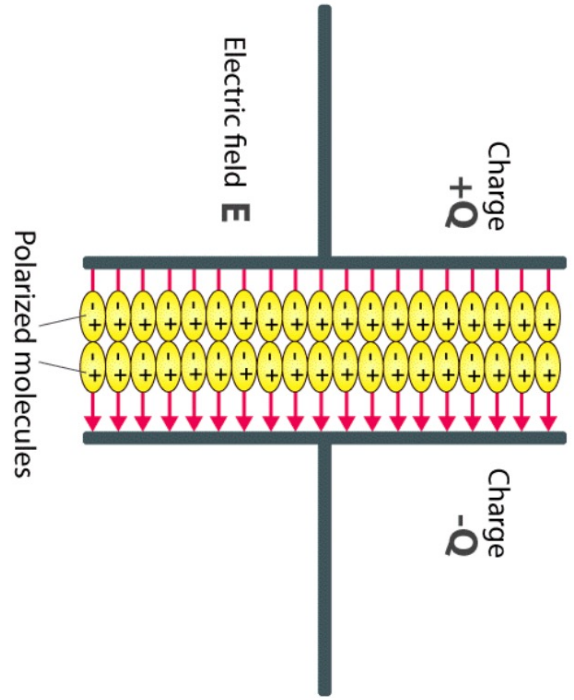


$$C[F] =$$

But Seriously….What is Capacitance?

$$C = \frac{\epsilon A}{d}$$

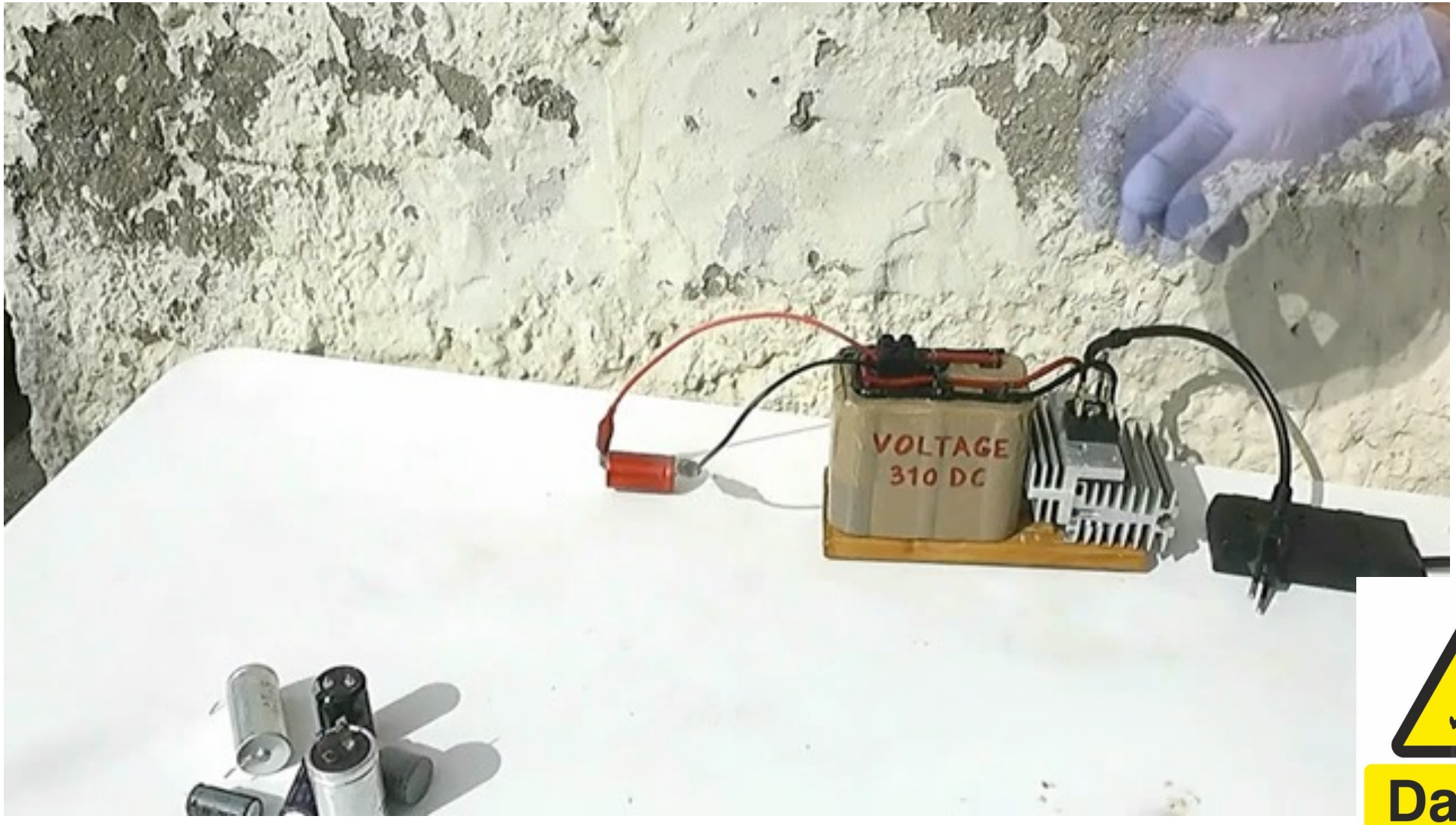




A dielectric is an insulator that can be polarized.
Polarization can increase the energy storage capacity!
Permittivity (ϵ) in [F/m] is a measure of the electric polarizability of a dielectric

$$\epsilon = \epsilon_o \epsilon_r \qquad \epsilon_o = 8.85 \times 10^{12} F/m$$

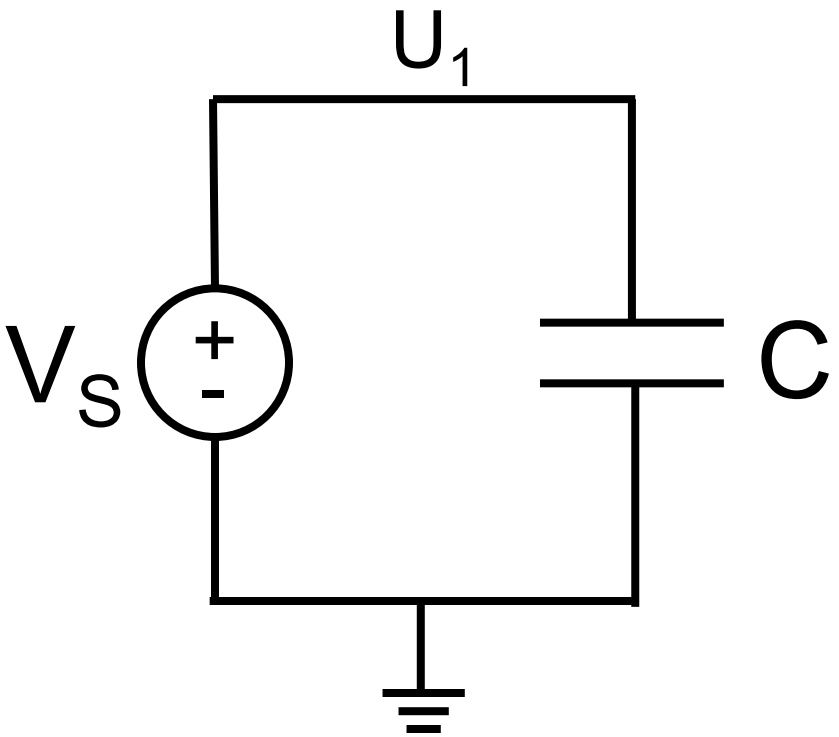
Electrolytic Capacitors and Explosions!



Experiments Robert33

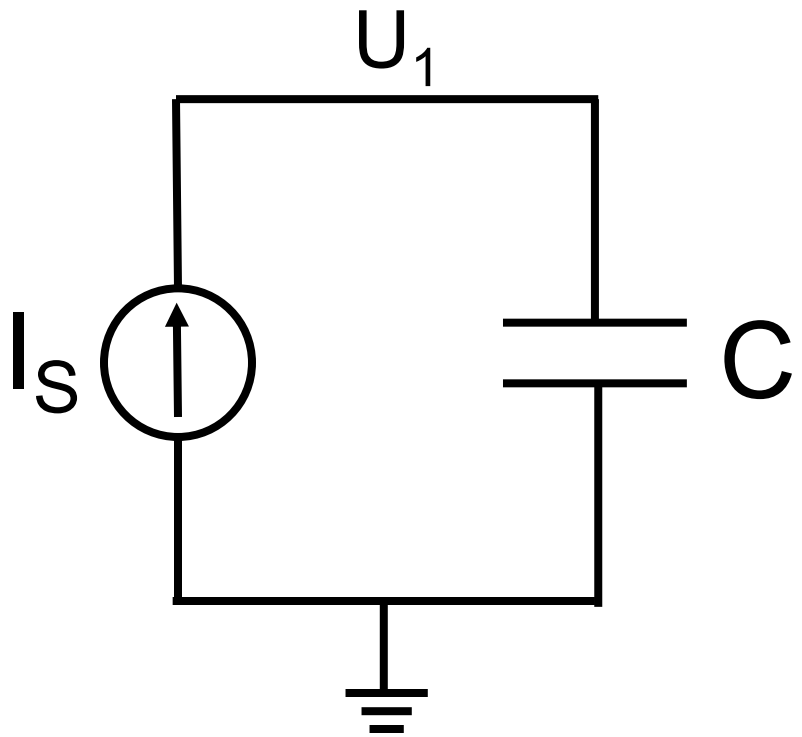
Circuit Example 1

Find the current in the capacitor I_C.



Circuit Example 2

At time t = 0, $U_1 = U_1(0)$ Volts
Plot U_1 vs. time



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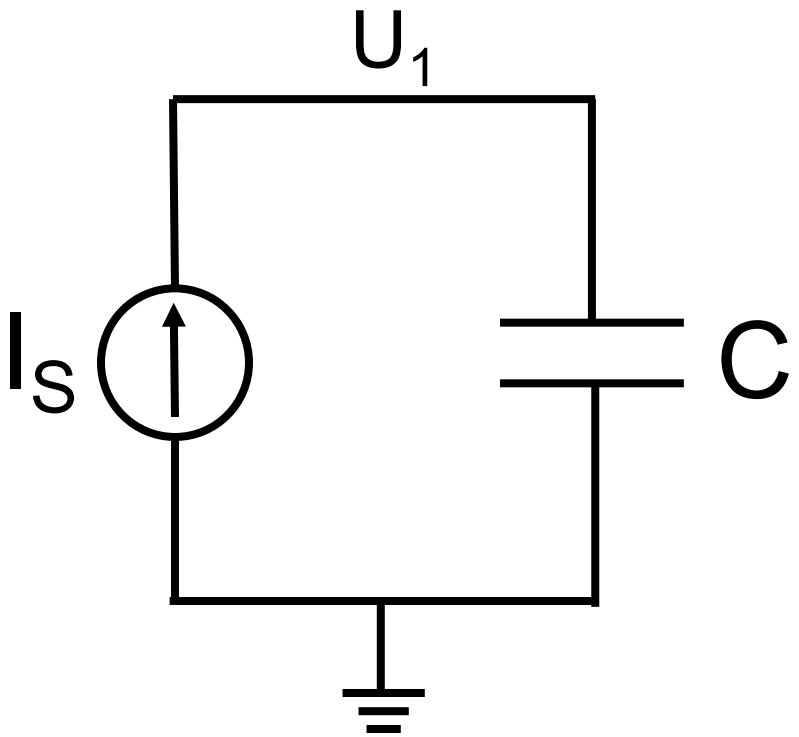

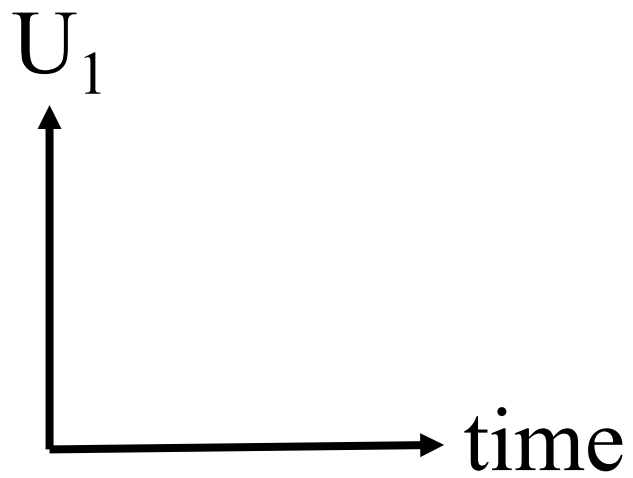

Circuit Example 3

What is the steady-state potential U_1?