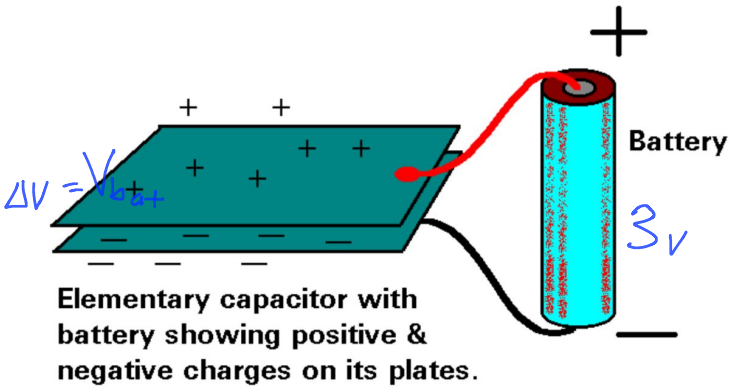
Modern Physics
Fall 2020

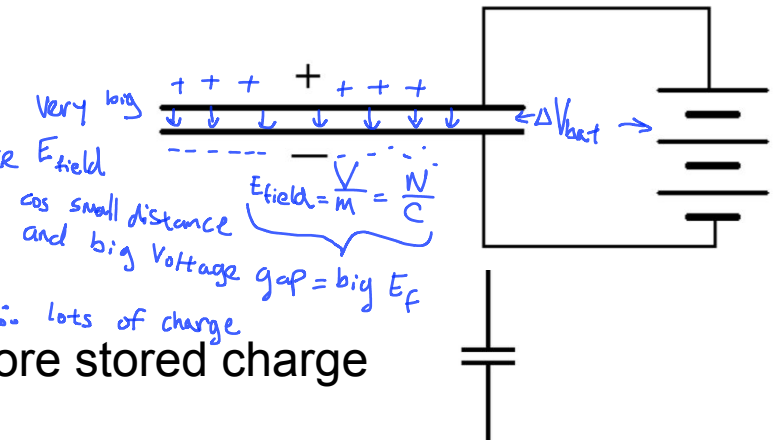
Name Albert H
Block 3
Date 23 Sep 2020

Capacitors

Store Charge



$\frac{Q}{V}$ = Capacetence E_{field}



More voltage → more stored charge
↳ bigger E_{field}

_____: Amount of charge a capacitor can store at a given voltage

Vars → Q, V

Variable: C

Unit: $\frac{C}{V}$

One Coulomb/Volt = 1 Farad F

Farads are BIG cuz Coulombs are big

OH GOD

$$F = \frac{C}{V} = \frac{A \cdot s}{V} = \frac{J}{V^2} = \frac{W \cdot s}{V^2} = \frac{N \cdot m}{V^2} = \frac{C^2}{J} = \frac{C^2}{N \cdot m} = \frac{s^2 \cdot C^2}{m^2 \cdot kg} = \frac{s^4 \cdot A^2}{m^2 \cdot kg} = \frac{s}{\Omega} = \frac{1}{\Omega \cdot Hz} = \frac{s^2}{H},$$

$F = \frac{S}{\Omega}$

$\frac{1}{\Omega} = \frac{A}{V}$

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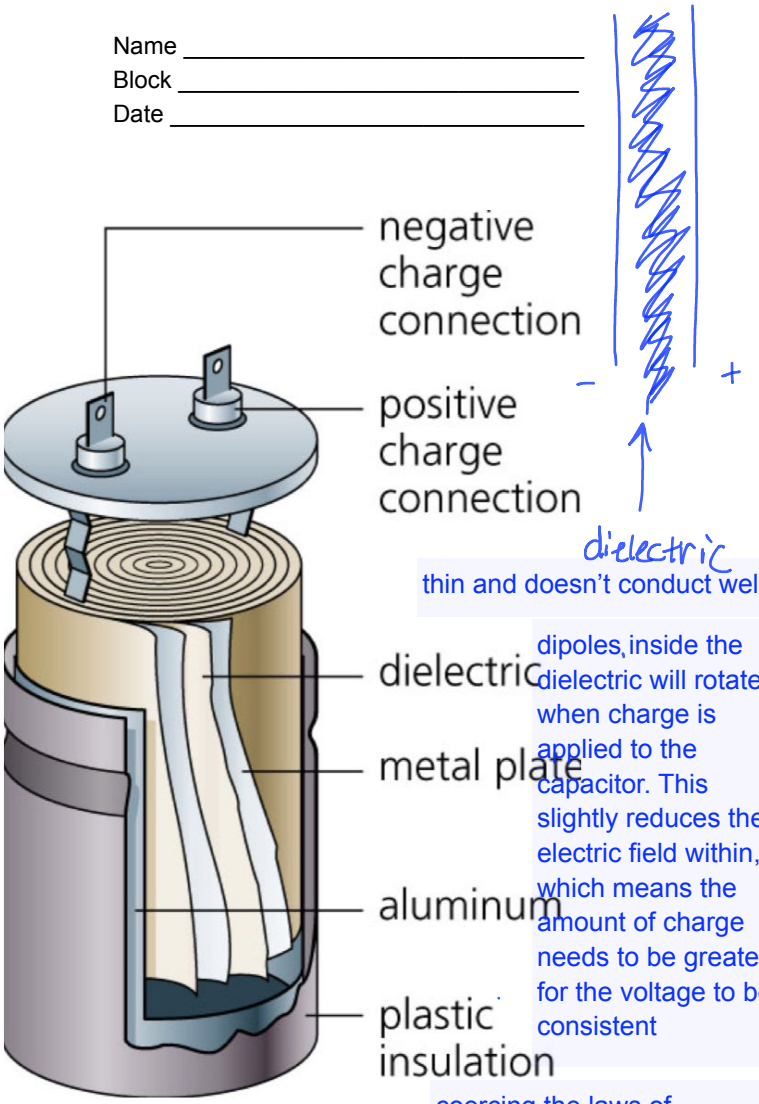
to increase charge:
increase area
decrease distance

Capacitance depends on
- Area
- Distance between plates
- Dielectric between plates



dielectric
thin and doesn't conduct well

dipoles inside the dielectric will rotate when charge is applied to the capacitor. This slightly reduces the electric field within, which means the amount of charge needs to be greater for the voltage to be consistent

Without dielectric

$$C = \frac{\varepsilon_0 A}{d}$$

$\frac{A}{d} = \frac{m^2}{m} = m$

coercing the laws of physics
to give us what we want

ε_0 "Electric Constant" - since 2008 MKS
(formerly "Permittivity of free space")
= $8.854 \times 10^{-12}\ C^2/N\ m^2$ (or F/m)

"no actual meaning, it's just a way of getting from point A to point B"

With stuff, "dielectric," between the plates:

$$C = \frac{\kappa \varepsilon_0 A}{d}$$

polar molecules can have stronger dipoles, and if molecules can move a little (soft) then it will make a better dielectric

κ → ~~relative permittivity of the dielectric~~ dielectric constant

greek letter kappa?

$K = \frac{1}{4\pi\varepsilon_0}$

$\kappa \neq K$

Coulomb's Law constant $F = k\frac{q_1 q_2}{r^2}$

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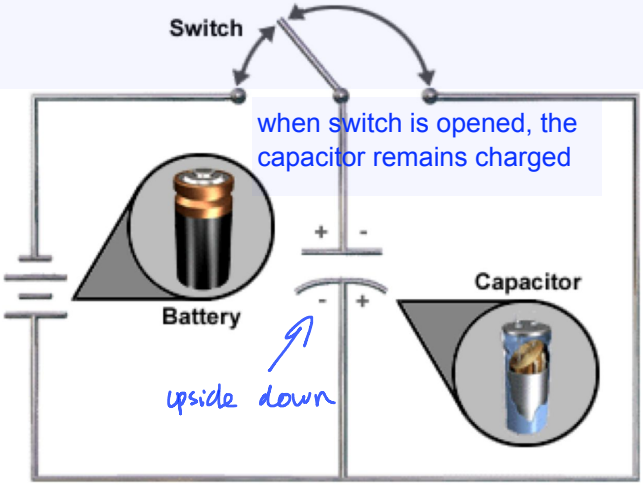
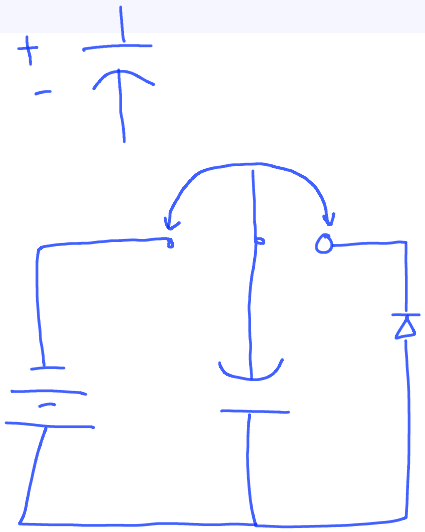
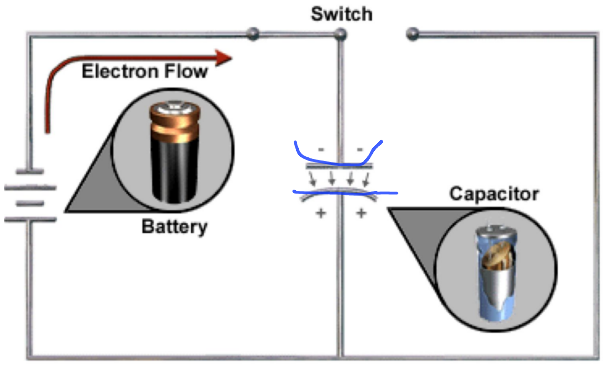
capacitor polarity:
the little flat ones don't, but the barrel ones do.
stripe with minus signs points to the negative terminal

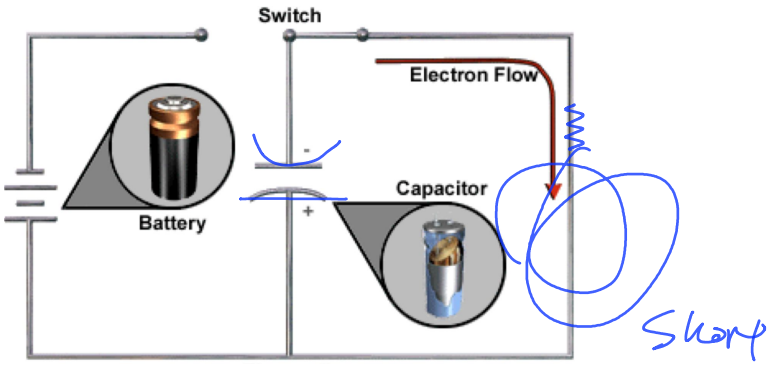
because the dielectric is more sophisticated, but when you go backwards the dielectric oxidizes and ~~blows up~~ expands rapidly and uncontrolably



when switch is opened, the capacitor remains charged







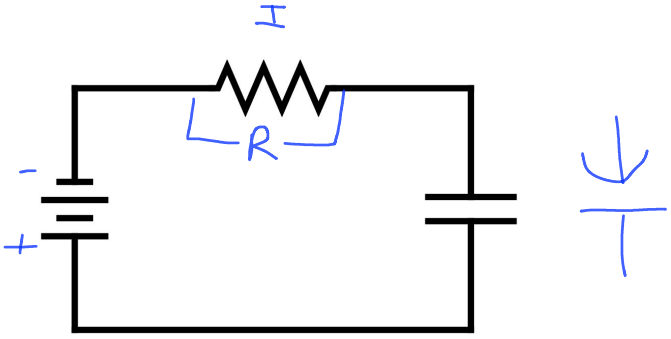
Short Circuit!

$V_{cap} = 0$
$t = 0 \quad I = \frac{V_{bat}}{R}$

$\Delta V = IR$
but ΔV changes can damage wires and capacitor

$V_{cap} < V_{bat}$

$I = \frac{V_{bat} - V_{cap}}{R}$



$V_{cap} = V_{bat}$

$F = \frac{C}{V} = \frac{S}{\Omega}$

$V_{cap} = V_{bat}\left(1 - e^{\left(\frac{-t}{\tau}\right)}\right)$

time (seconds) to charge 2/3 of the way

$\tau = RC$

euler's constant, ohms, Farads