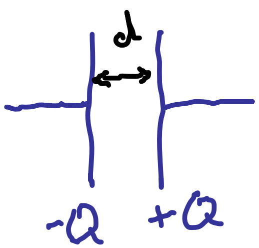
Physics 142 - October 2, 2014

- Exam 1 next Tuesday - here - During lecture
  organizational questions/issues?
- Q+A session Monday at 5:30 B+L 109
- Workshops go on as usual next week
  ... as do problem sets
  both shorter than usual

Last Time

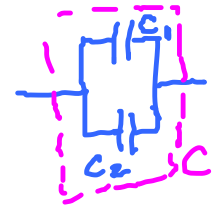
- Capacitance of parallel plate capacitor



$$C = \frac{\epsilon_0 A}{d}$$

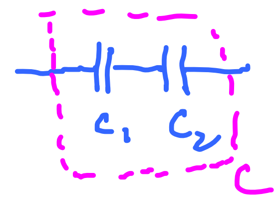
geometry only
Different for Different systems

- capacitors in parallel



$$C = \sum_i C_i$$

- Capacitors in Series



$$\frac{1}{C} = \sum_i \frac{1}{C_i}$$

- Energy Stored in a capacitor

$$U = \frac{1}{2} C V^2 = \frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} Q V$$

- Energy density in Electric Field

$$u_E = \frac{\epsilon_0}{2} |E|^2$$

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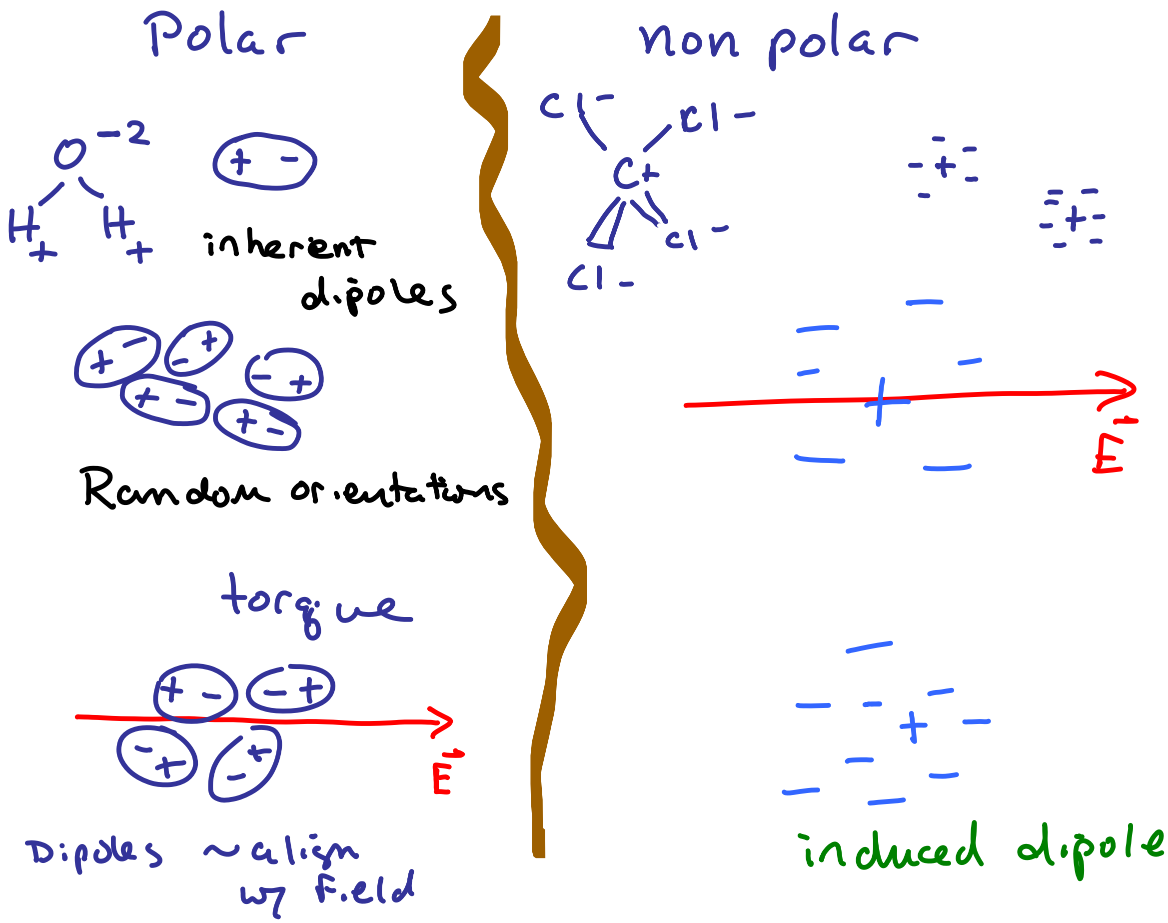
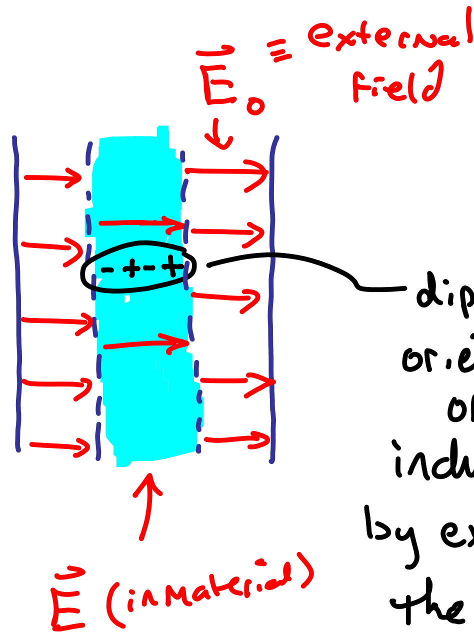
if know $\vec{E}$

$$U = \int_{vol} u_E \, dv$$

$\vec{E}$ in materials – dielectric (nonconductor)



(linear) Dielectrics
$\vec{E}$ in materials



by external field "weaken" the field in the material

linear

$$\vec{E} \propto \vec{E}_0$$

$$\vec{E} = \frac{\vec{E}_0}{K}$$

K ≡ Dielectric constant (varies by material)

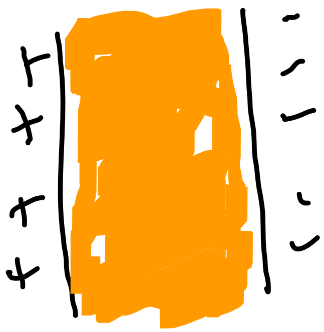
$K > 1$

$K_{water} = 80.4$ $K_{air} = 1.00054$

$K_{vacuum} = 1$ oil = 4.5

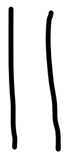
$$K \epsilon_0 \equiv \epsilon$$

↑ = Permittivity



$$\vec{E}_0 = \sigma / \epsilon_0$$

$$\vec{E} = \frac{\vec{E}_0}{K} = \frac{\sigma}{K\epsilon_0} = \frac{\sigma}{\epsilon}$$



$$Q = CV$$

No dielectric → with dielectric

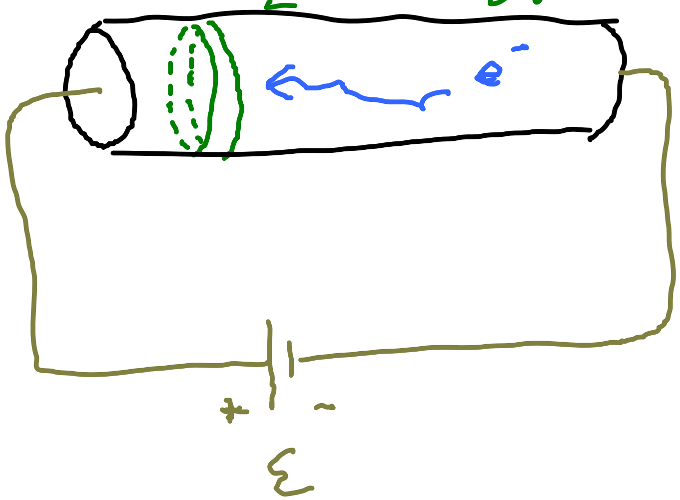
$$V \longrightarrow V/K$$

$$C \longrightarrow KC = K\frac{\epsilon_0 A}{d} = \frac{\epsilon A}{d}$$

$$Q = c'\frac{V}{K} \rightarrow \underbrace{\boxed{\frac{Q}{V}}}_{c} K = c'$$

Currents and resistance

$dq/dt \equiv i \equiv$ current



\+ Current flow is direction + charge would move

Resistance impedes electrons as the look for love

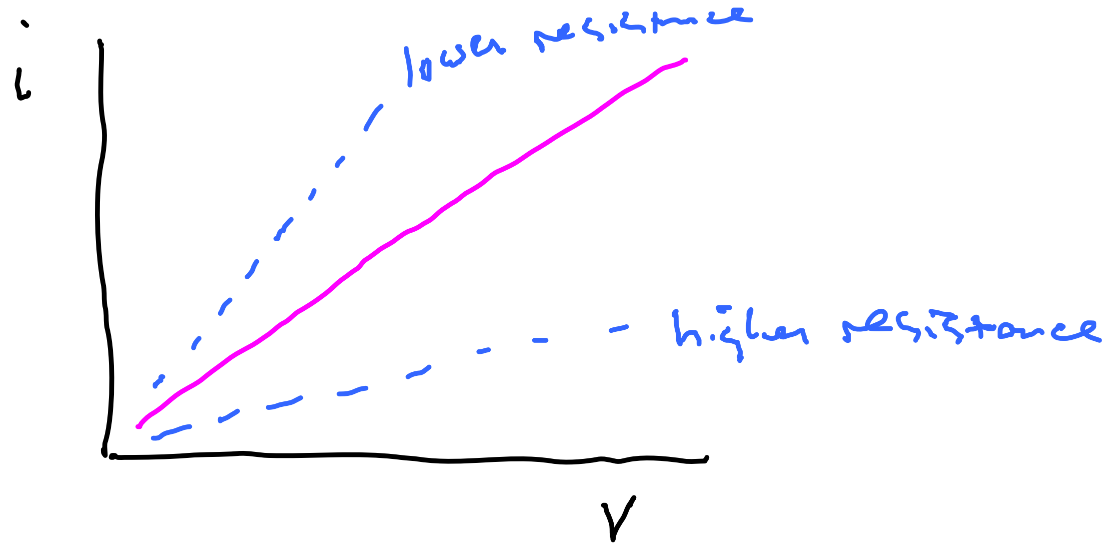
$$i \equiv \frac{dq}{dt} \text{ in units of } \frac{\text{Coulombs}}{\text{sec}} \equiv \text{Ampere}$$

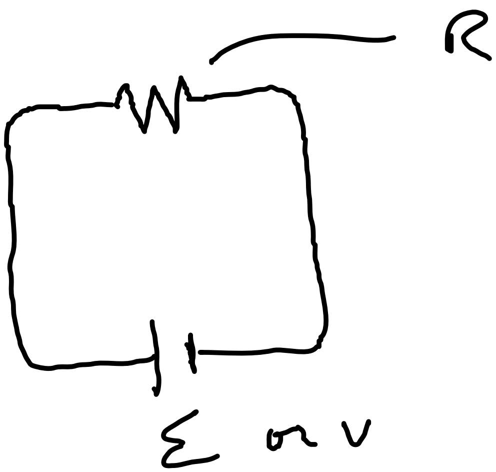
$i \propto V$

$$\boxed{V = iR}$$

R ← Resistance — units Ohm's

Ohm's Law



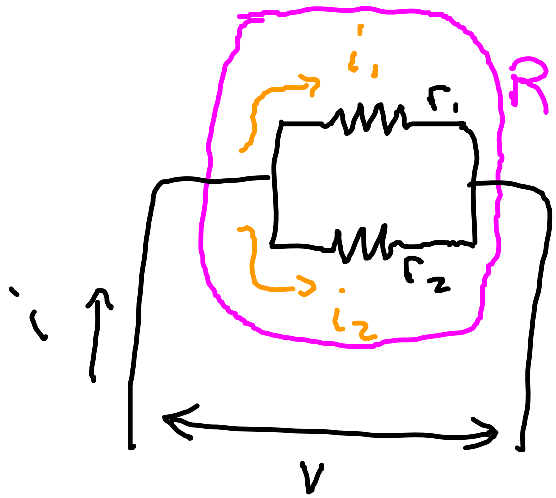


$$V = w/q$$

$$w = qV$$

$$\frac{dw}{dt} = \frac{dq}{dt} V = iV \equiv \text{Power} = P$$

$$P = iV = \frac{V^2}{R} = i^2 R$$



Resistors in parallel

$$V = iR$$

$$V = i_1 r_1$$

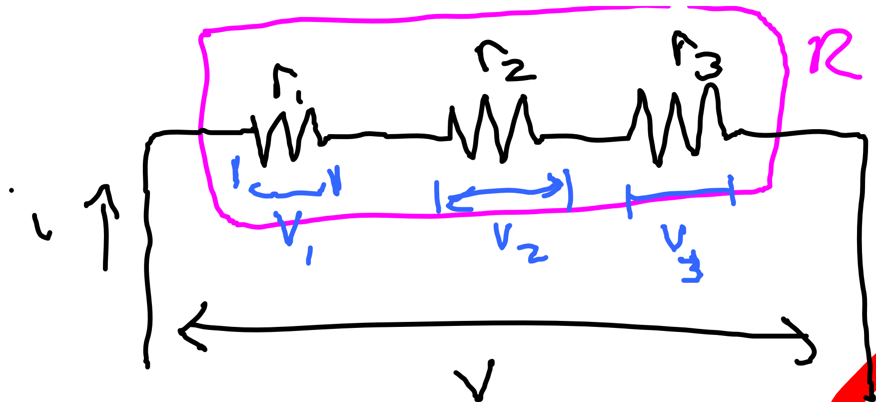
$$V = i_2 r_2$$

$$i = i_1 + i_2$$

$$\frac{V}{R} = \frac{V}{r_1} + \frac{V}{r_2}$$

$$\frac{1}{R} = \sum_i \frac{1}{r_i}$$

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2}$$



Resistors in series

$$V = iR$$

$$V = V_1 + V_2 + V_3$$

$$iR = ir_1 + ir_2 + ir_3$$

$$R = r_1 + r_2 + r_3$$

$$R = \sum_i r_i$$

	Capacitors	Resistors
Parallel	$C = \sum_i C_i$	$\frac{1}{R} = \sum_i \frac{1}{R_i}$
Series	$\frac{1}{C} = \sum_i \frac{1}{C_i}$	$R = \sum_i R_i$

Convention

[told this is opposite that of ECE 210]
↳ no matter if consistent

Choose currents in each branch (arbitrary)

Sum ΔV across each circuit component as you go around an imaginary closed loop in the circuit

ΔV − if 

ε + if 

ΔV + if 

ε − if 

Get N eqns, N unknowns and solve

Tedious → must be careful and consistent w/ conventions and signs

Use only independent loops