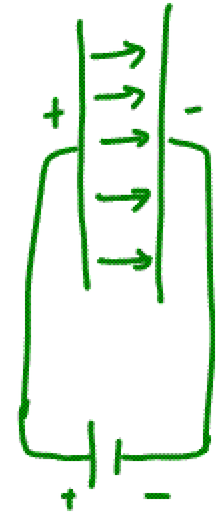
Physics 142 - October 9, 2007

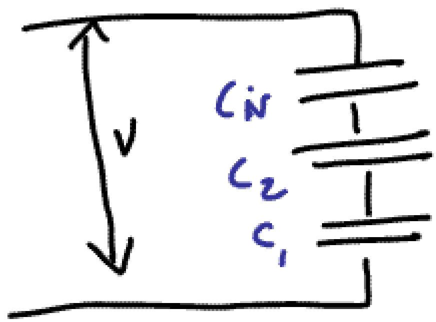
- Exam 1 being graded - goal is to hand it back on Thursday
- Solns to exam to be placed online when exam returned
- Presentations

Parallel Plate Capacitor

$$C = \frac{Q}{V} = \frac{|\vec{E}| A \epsilon_0}{|\vec{E}| d} = \frac{A \epsilon_0}{d}$$

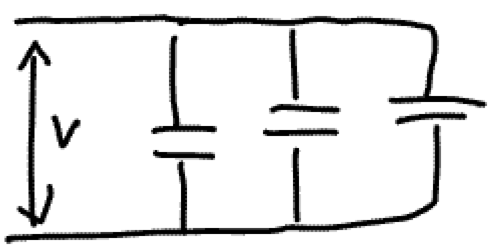
geometry only





capacitors in Series

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



Capacitors in //

$$C = \sum C_i$$

Energy Stored in capacitors

$$U = \frac{1}{2} C V^2 \quad \text{or} \quad U = Q^2/2C$$

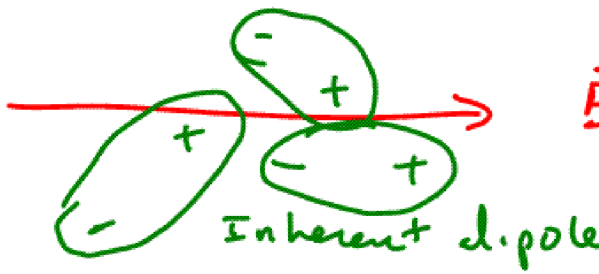
Energy density in Electric field

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

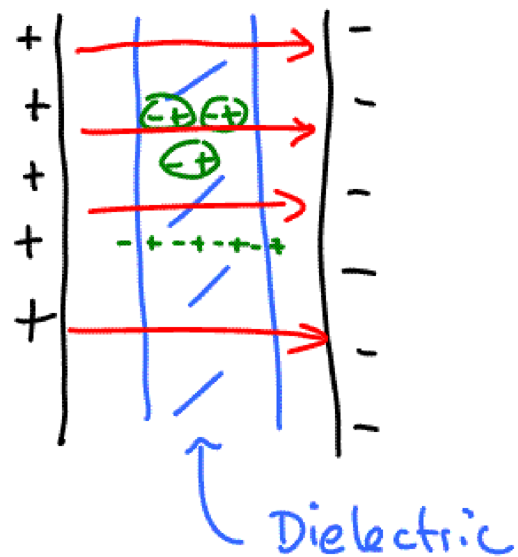
Electric fields in nonconductors

Insulator ↳ Dielectric

Polar Material --- polar molecule



$\vec{E}$ → produces torque



minor separation of charge → create Dipole across material

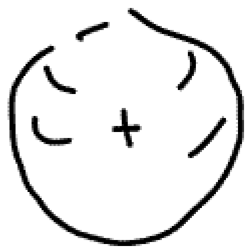
$\propto E$

Linear Dielectric

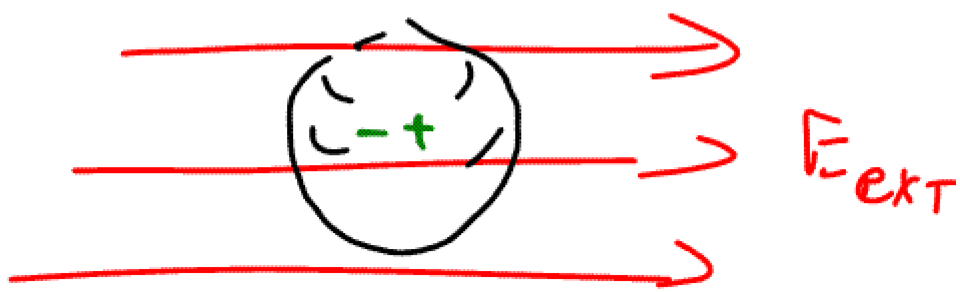
induced $E \propto E_{external}$

" " goes away when $E_{ext} \to 0$

non polar Materials



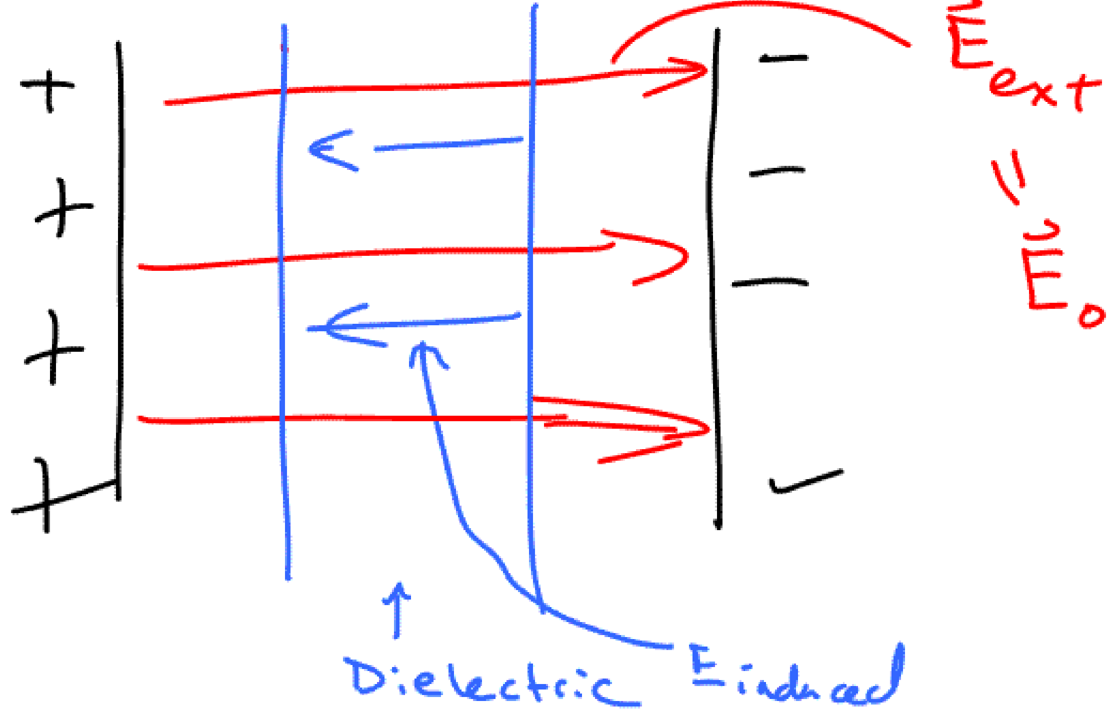
no inherent dipole



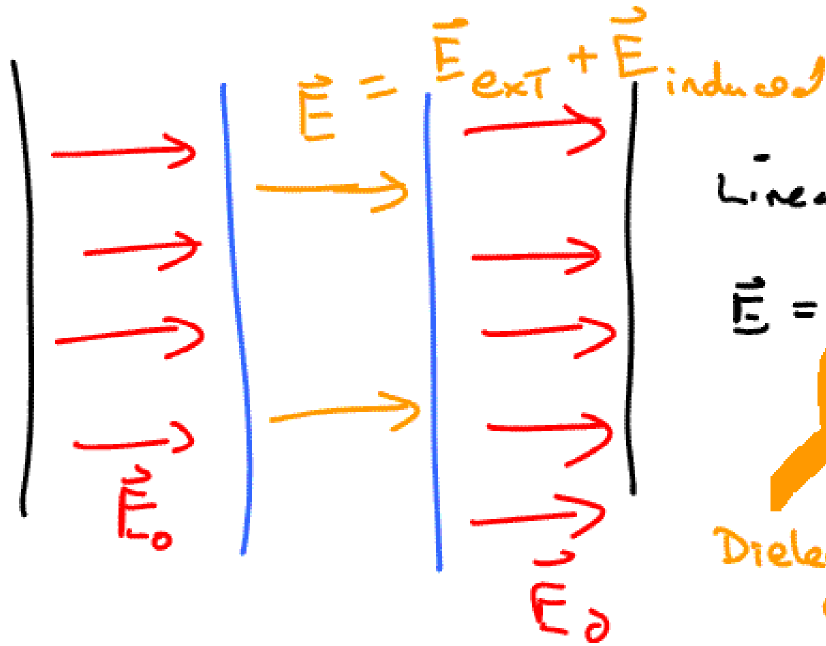
induced dipole

charge sep ... dipole

$\propto E_{ext}$



$\vec{E}$ is Material Dependent



Linear dielectric

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

$K > 1$

Dielectric constant

$|\vec{E}| < |\vec{E}_0|$

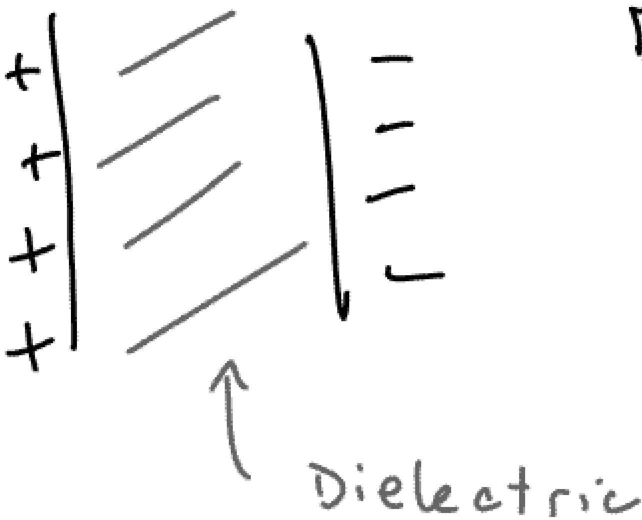
$K > 1$

Water $K = 80.4$

Air $K = 1.00054$

Vacuum $K = 1$

Oil $K = 4.5$



No Dielectric

$\vec{E}_0$ or $\vec{E}_{ext} = \sigma / \epsilon_0$

w/ Dielectric

$$|\vec{E}| = \frac{\sigma}{K\epsilon_0}$$

$$Q = CV$$

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

$$V \rightarrow \frac{V}{K}$$

No Diel.   Diel

$$C \rightarrow CK = \frac{K \epsilon_0 A}{d}$$

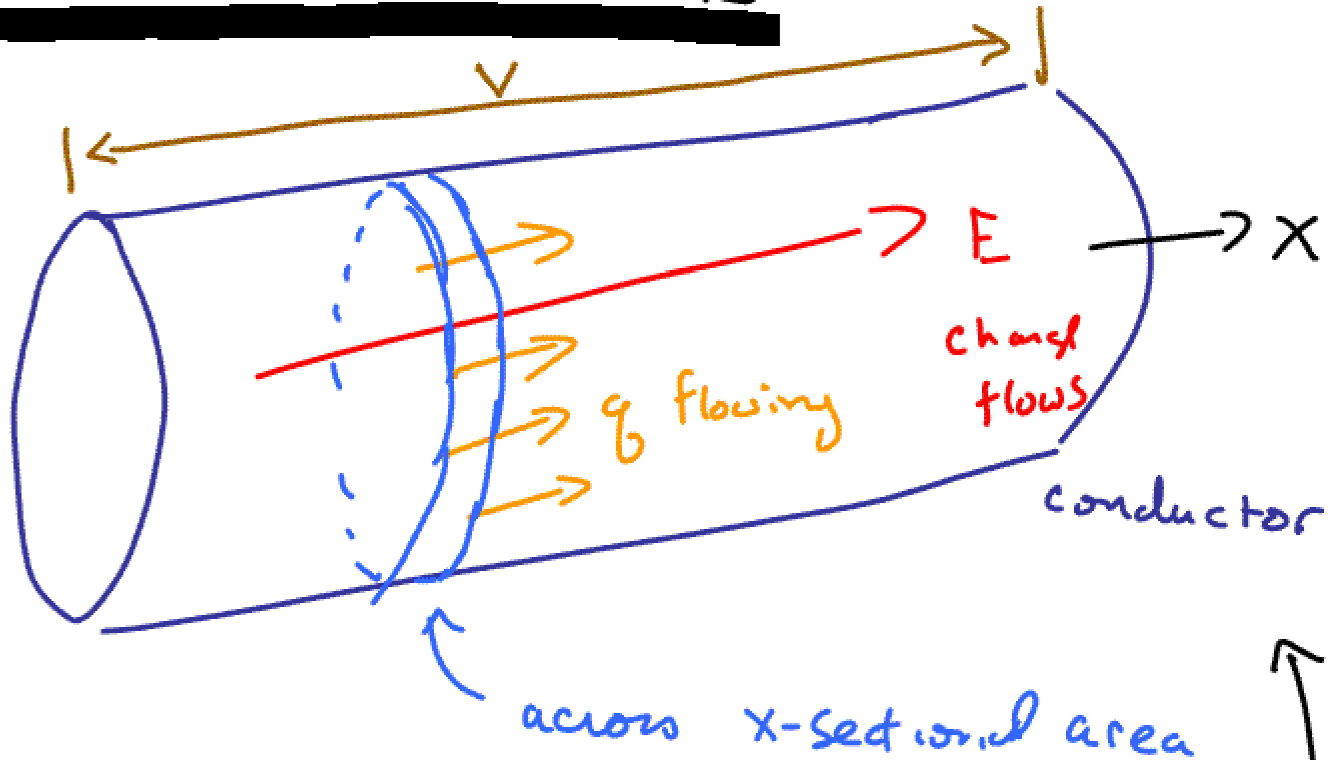
$K \equiv$ dielectric constant

$$K \epsilon_0 \longrightarrow \epsilon$$

ϵ_0: Permittivity of free space

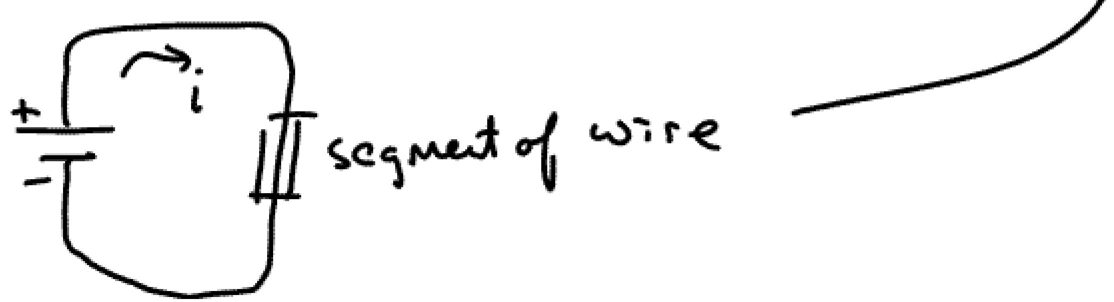
ϵ: permittivity

Current and Circuits

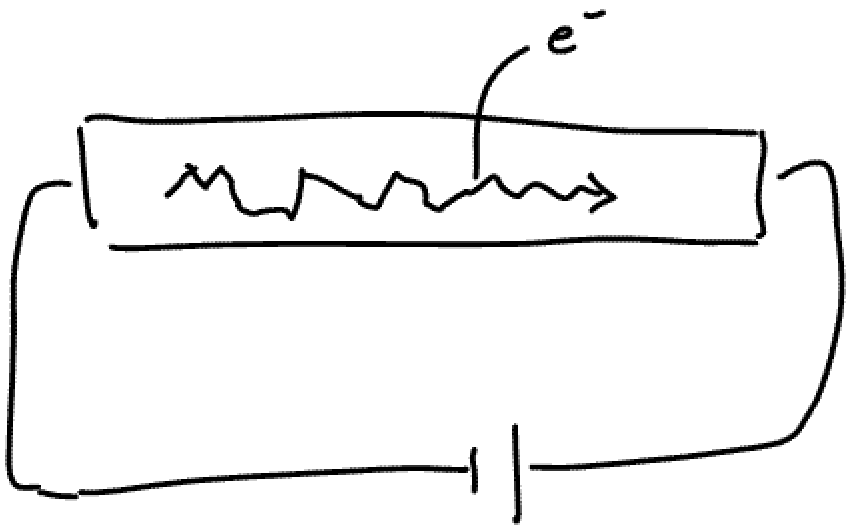


$$E = -\frac{dV}{dx}$$

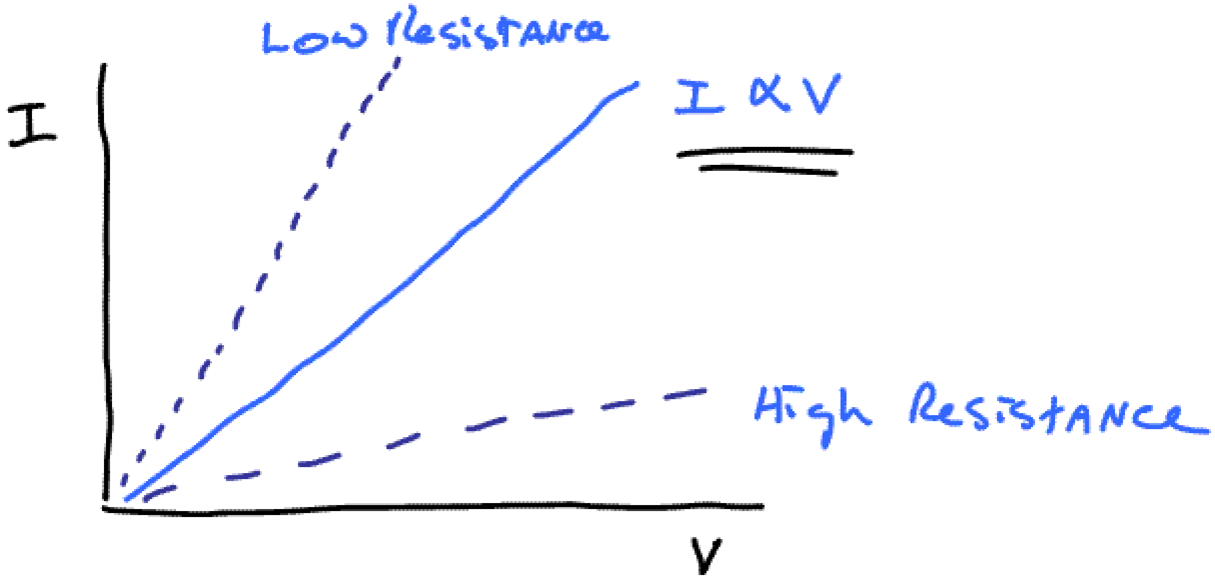
$$\frac{dq}{dt} \equiv i \quad \text{current}$$



+ i → direction that + charges would go



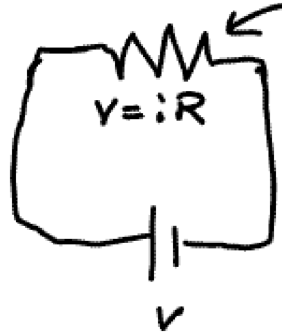
little collisions → resistance



Ohm's Law $V = I R$

$I \propto V$

constant of proportionality is R



Resistor

perfectly conducting wire

$V = \frac{w}{q}$ across Resistor

$w = qV$

$\frac{dq}{dt} \equiv i$

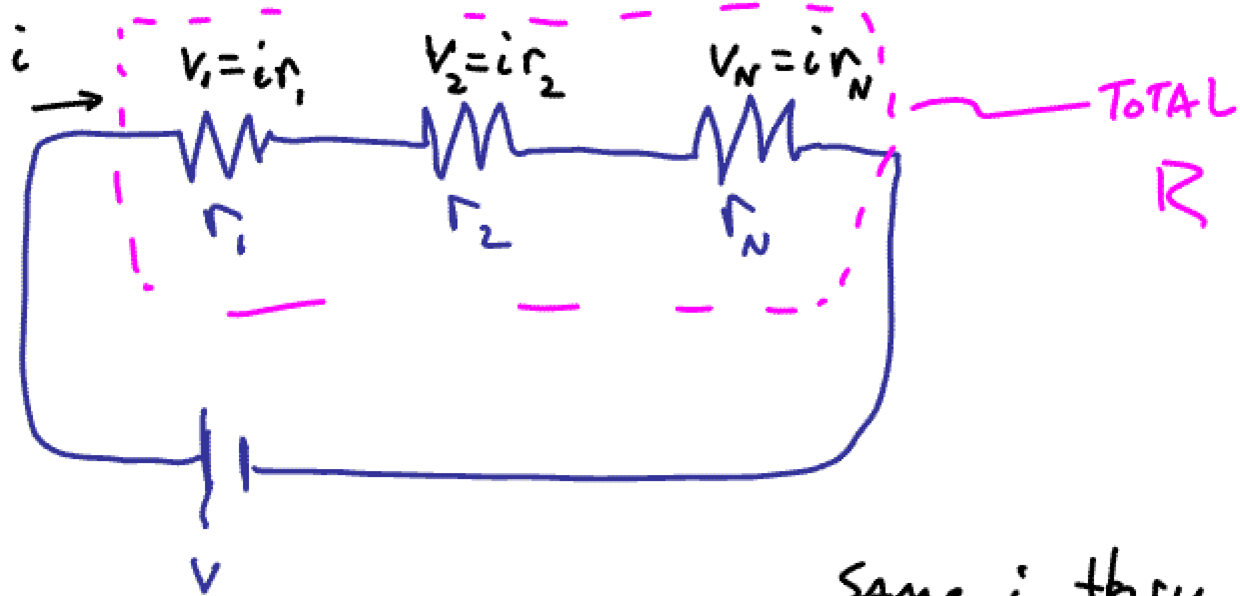
$$\frac{dw}{dt} = \frac{dq}{dt} V = i V$$

Power dissipated in Resistor

$P = iV$

$V = iR$ $\quad P = i^2 R$

$P = V^2/R$



Same i thru each resistor

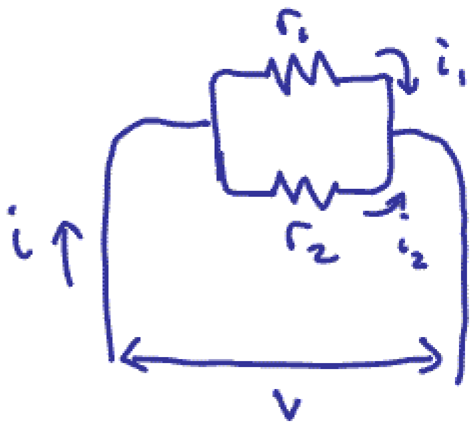
$$V = iR$$

$$V = V_1 + V_2 + \cdots + V_N = i r_1 + i r_2 + \cdots + i r_N$$

$$= i\,(r_1 + r_2 + \cdots r_N)$$

$$R = \sum_i r_i$$

Resistors in series



$$r_1 = \frac{V}{i_1} \qquad r_2 = \frac{V}{i_2}$$

$$i = i_1 + i_2$$

$$i = \frac{V}{R}$$

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

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

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

Resistors in Parallel

Possible Source of Confusion

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