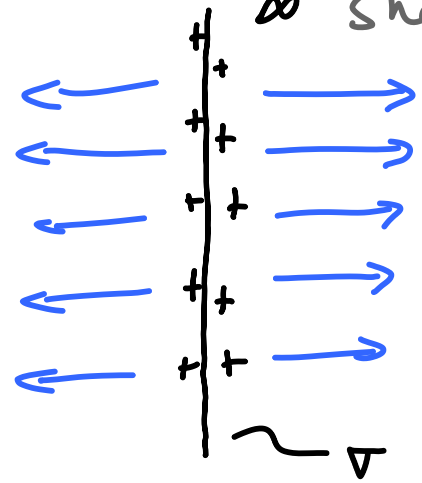
Physics 142 - September 30, 2010

- Exam I - Thurs., Oct. 7 8 am
  Location → B+L 109
- Material
  - Thru chapter 25 (No capacitors)
  - Thru page 6 of Sept 28 lecture
  - Thru Workshop 3 + P.S. 4 (NOT prob 10)
- Calculator ok
- Past exams on web
- 3x5 inch index card, both sides, w/ notes ok
- Prob. set return

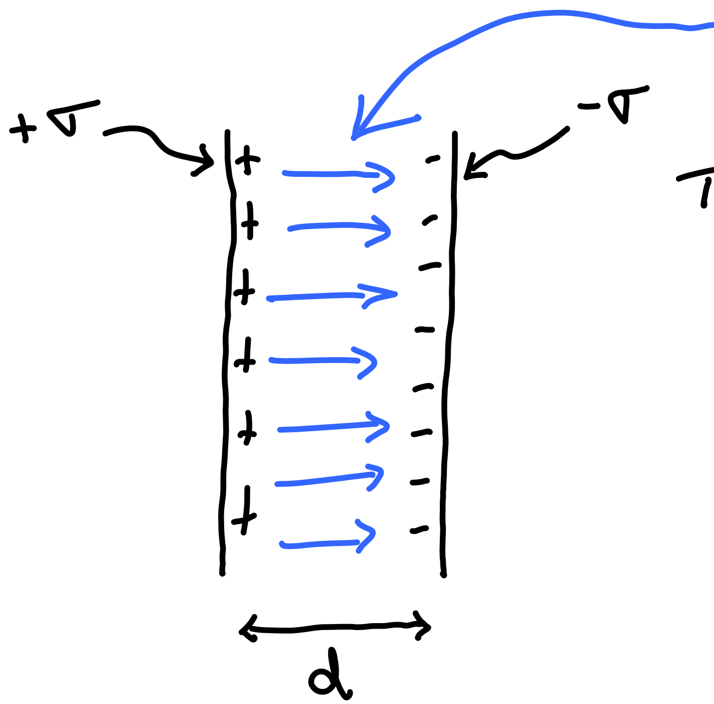
Last Time

∞ sheet of charge



$\vec{E} = \sigma / 2\epsilon_0$ away from sheet

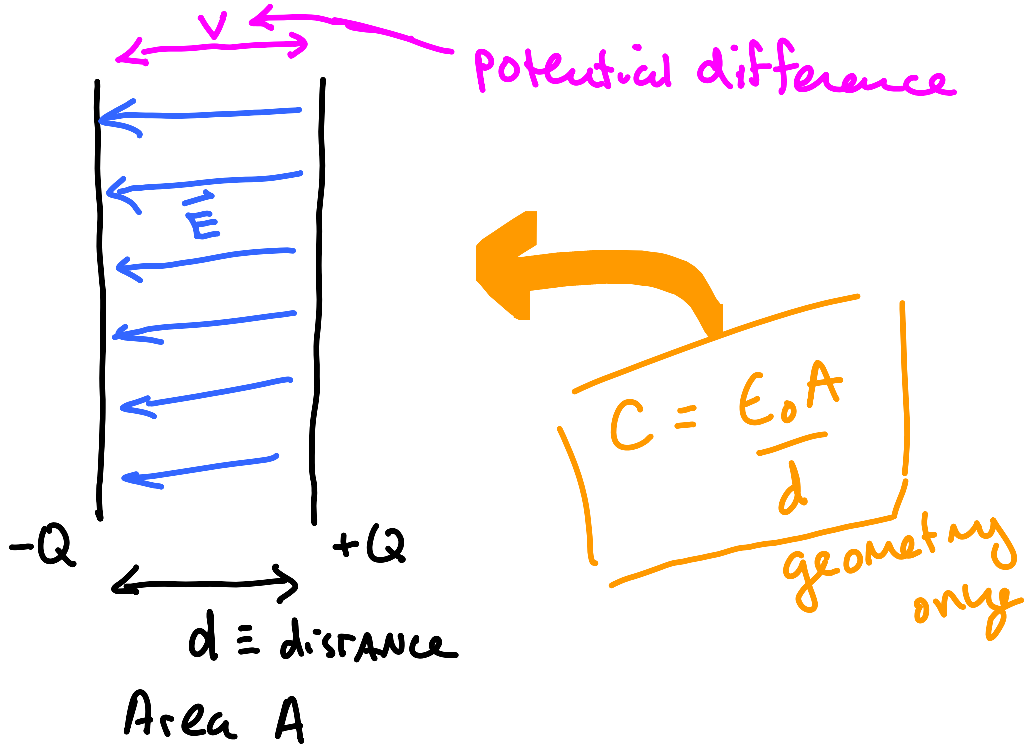
$|\vec{E}| = \sigma / \epsilon_0$



Two ∞ sheets

$+\sigma$, $-\sigma$

separated by d



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

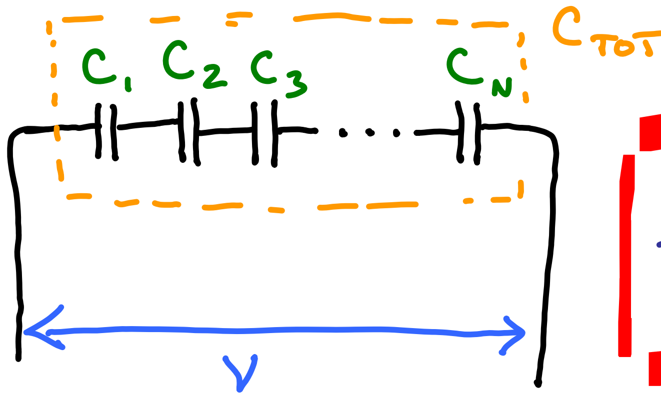
$$Q = CV$$

≡ Capacitance (MKS unit - Farads)

General relationship

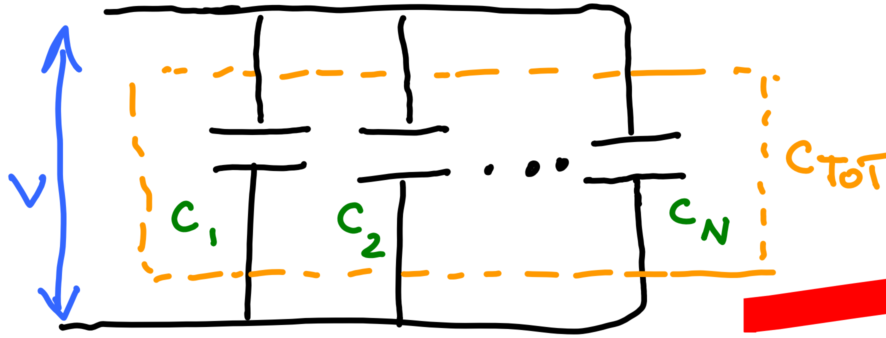
Depends on geometry only

Capacitors in series

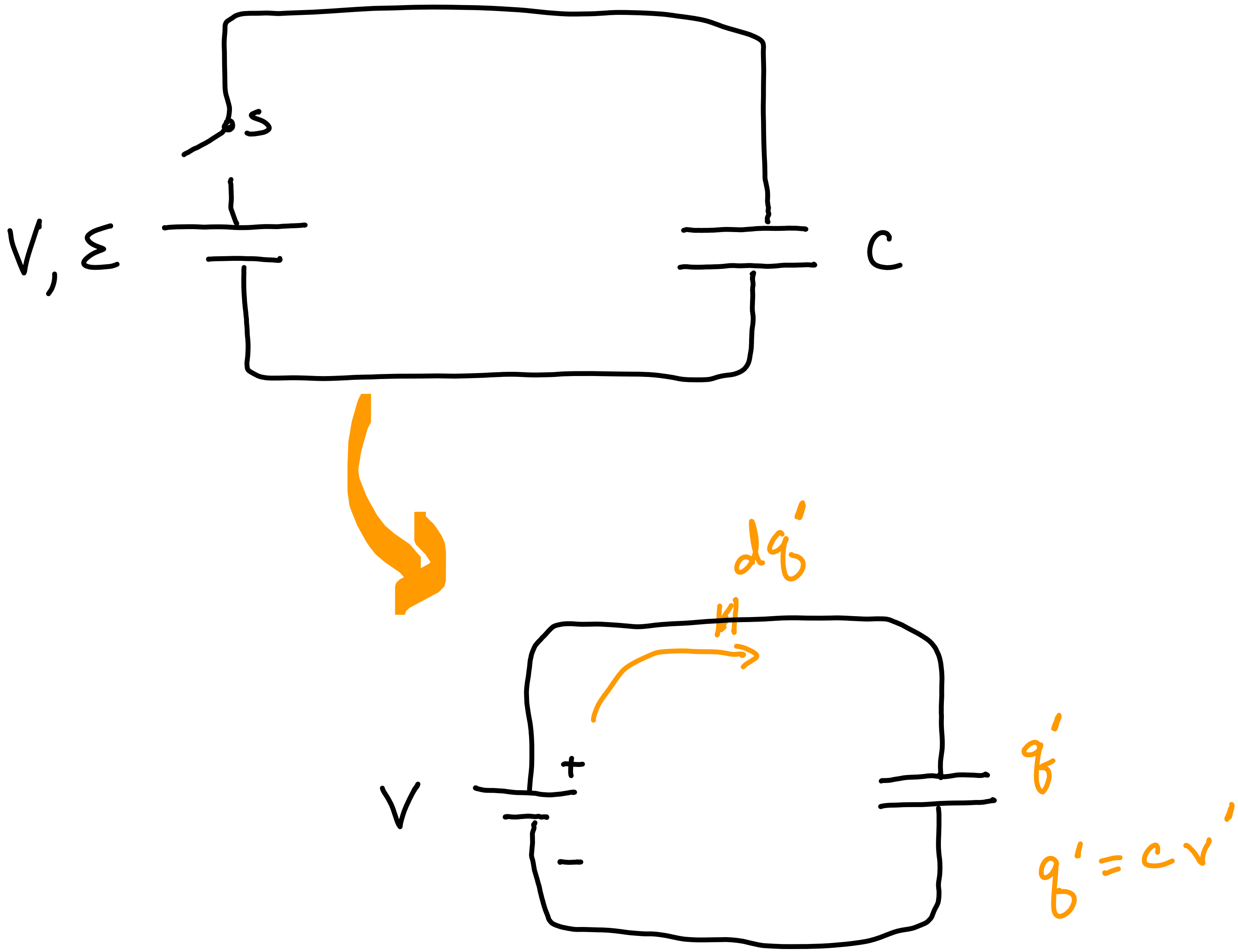


$$\frac{1}{C_{TOT}} = \sum_{i=1}^{N} \frac{1}{C_i}$$

Capacitors in Parallel



$$C_{TOT} = \sum_{i=1}^{N} C_i$$



V, ε
s
C
V
+
−
dq'
q'
q' = cv'

$$dw = V' dq' \qquad q' = CV'$$

$$dw = \frac{q'}{C} dq' \qquad Q = CV$$

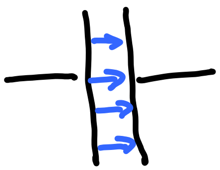
$$W = \int dw = \int_0^Q \frac{q'}{C} dq' = \frac{1}{C}\frac{Q^2}{2} = \frac{1}{C}\frac{C^2V^2}{2} = \frac{1}{2}CV^2$$

$W =$ Energy to charge capacitor $= U = \frac{1}{2}CV^2$

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

Energy Stored in Capacitor

Energy density of the electric field



$$u_E \equiv \frac{U_{\text{Total energy}}}{\text{Vol. between plates}} = \frac{\frac{1}{2} C V^2}{d\,A}$$

C of // plates $= \dfrac{A \epsilon_0}{d}$

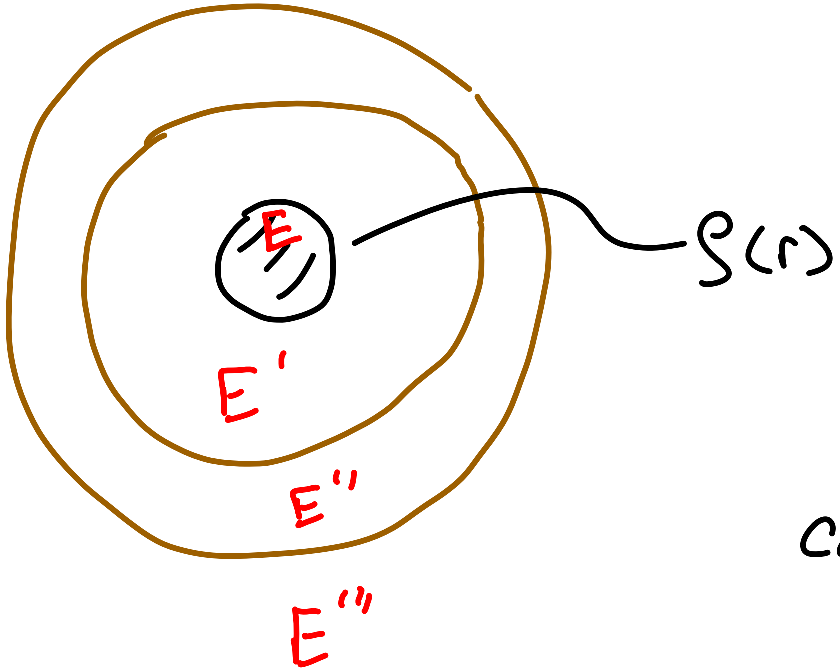
$$\downarrow$$

$$\frac{\frac{1}{2}\frac{A \epsilon_0}{d} V^2}{d\,A}$$

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

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

general Result!

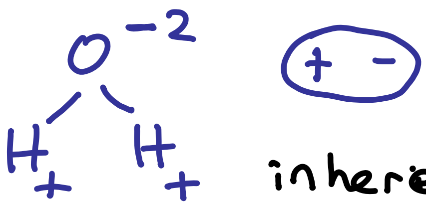


Calc total E stored in system

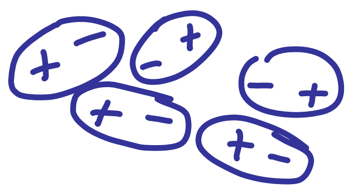
$$U = \int_{vol} u_E \, dv$$

$\vec{E}$ in materials – dielectric

Polar

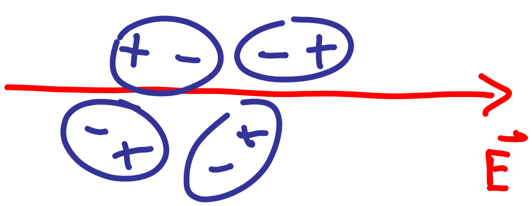


inherent dipoles



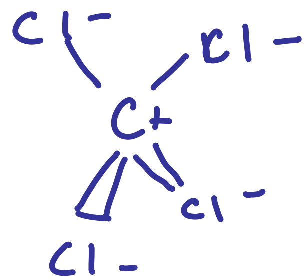
Random orientations

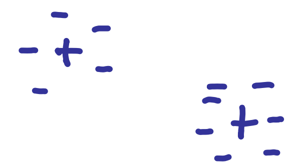
torque

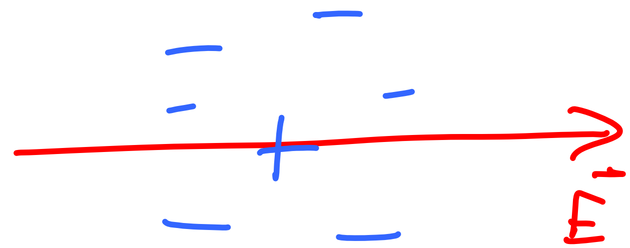


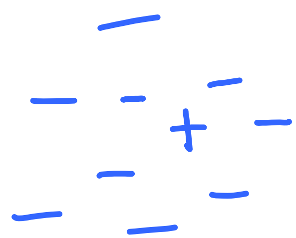
Dipoles ~align w/ field

non polar





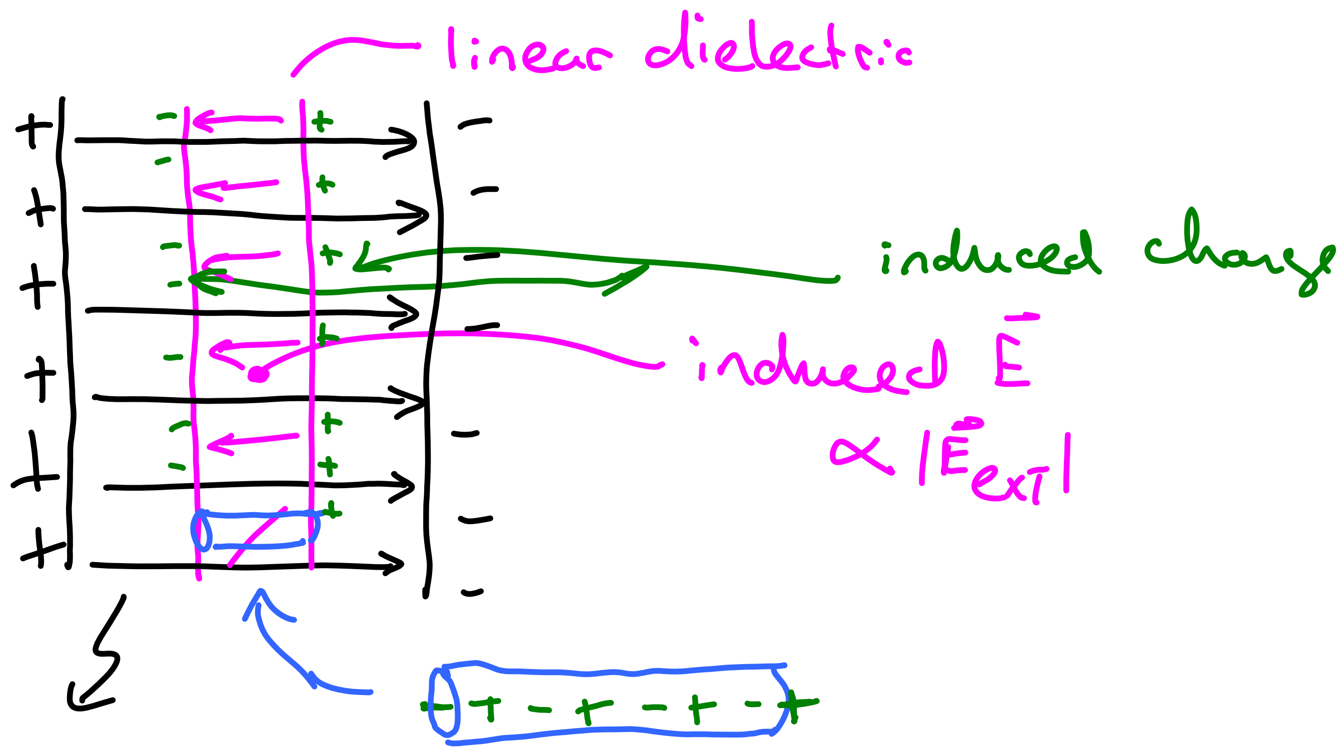




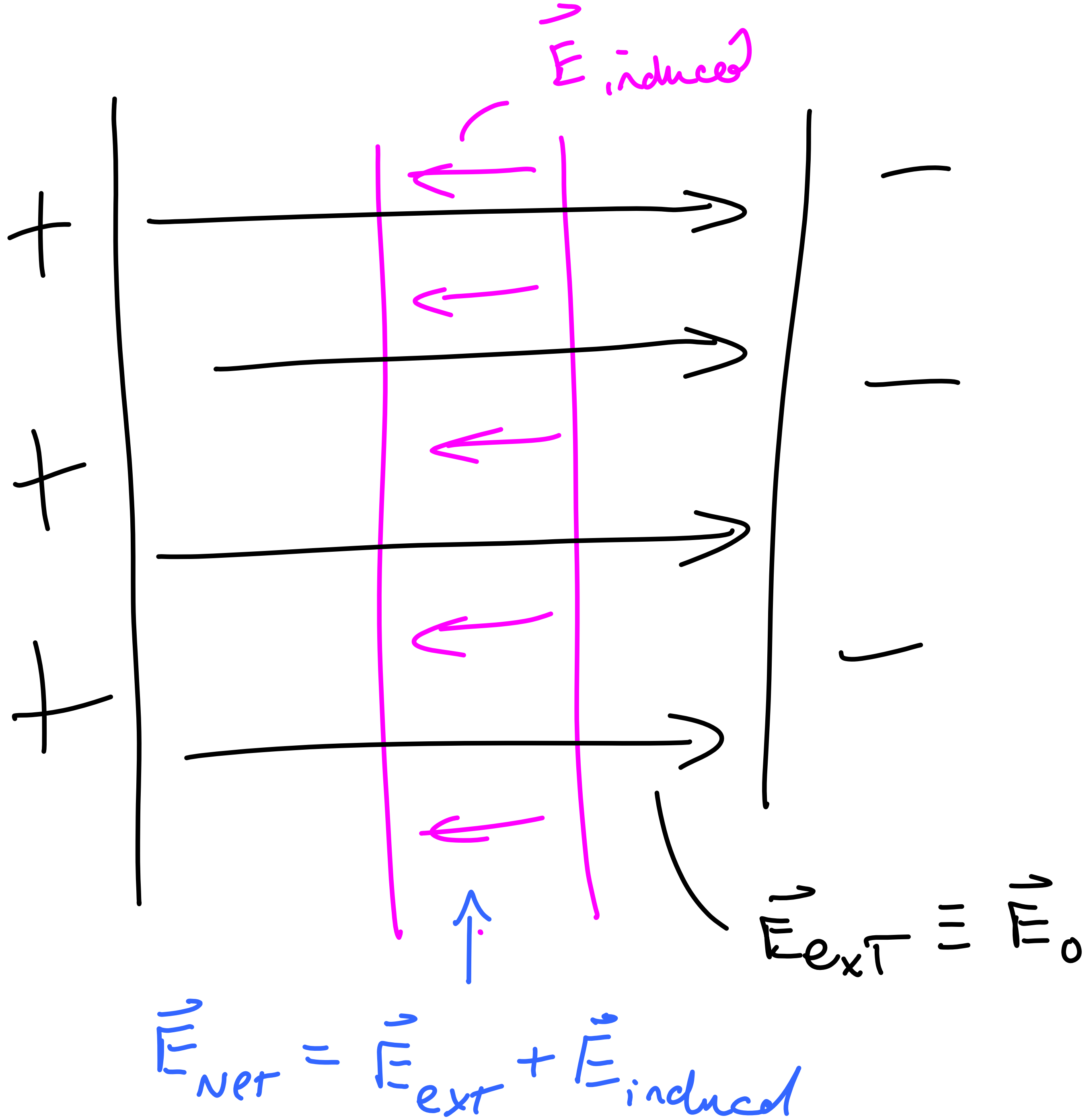
induced dipole

dipoles aligned $\propto |\vec{E}|$

"linear dielectric"



$\vec{E}_{ext}$ = External Electric field



$\vec{E}_{induced}$
$\vec{E}_{ext} \equiv \vec{E}_0$
$\vec{E}_{net} = \vec{E}_{ext} + \vec{E}_{induced}$

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

Net $\vec{E}$ in Material

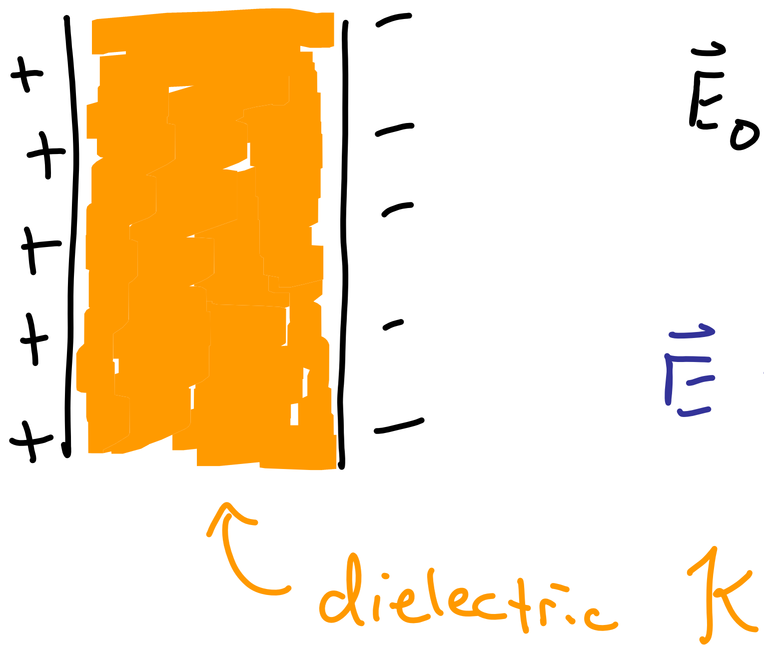
dielectric constant

$\kappa > 1$

depend on Material

$\kappa > 1$

Water	$\kappa = 80.4$
air	1.00054
Vacuum	1
oil	4.5



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

$$\vec{E} = \frac{\sigma}{\epsilon_0 \kappa}$$

$$\kappa \epsilon_0 \longrightarrow \epsilon$$

ϵ_0 ↑ Permittivity of free space

ϵ ↑ Permittivity

$$\vec{E} = \frac{\sigma}{\epsilon}$$

$$Q = CV$$

NOT Attached to Battery

$V \longrightarrow \dfrac{V}{K}$

No dielectric ↕ (V) | dielectric ↕ ($\dfrac{V}{K}$)

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