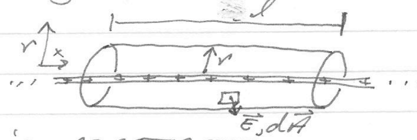
Infinite Line of Charge



line of charge

→ λ is linear charge density + is constant

→ by symmetry, $\vec{E}$ must be directed radially (no 'x' component)

→ so a cylindrical symmetry is apparent

→ so closed surface is a cylinder of length l

$$\phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{q}{\epsilon_0} \quad q = \lambda l$$

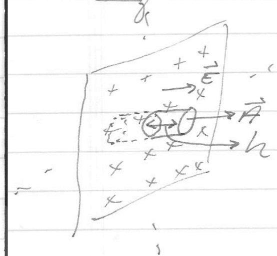
($\vec{E}$ constant on cylinder)

$$E \oint dA = \lambda l / \epsilon_0$$

($\oint dA = 2\pi r l$)

$$\boxed{E = 2k \frac{\lambda}{r}}$$ → direction radially

Infinite Sheet of Charge



- uniform charge density $\sigma = q/A$
- $\vec{E} \perp$ to surface by symmetry

→ construct cylinder $\perp$ to plane

→ no flux thru cylinder, only thru ends

$$\phi_E = \oint \vec{E} \cdot d\vec{A} = q/\epsilon_0$$

$$EA + EA = \sigma A/\epsilon_0$$

$$E = \frac{\sigma}{2\epsilon_0}$$

- no radial dependance

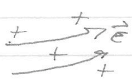
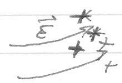
∴ E field same for all points on each side of sheet

Charged Conductors in Electrostatic Equilibrium:

electrostatic equilibrium = no net motion of charges

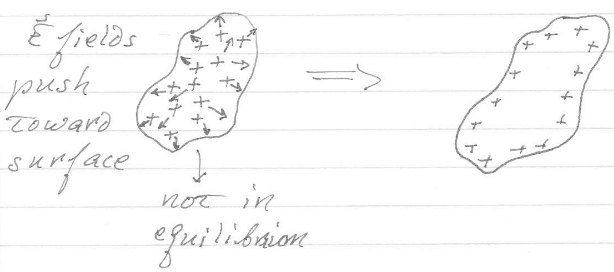
→ several consequences of this scenario

A) $\vec{E} = 0$ at all points inside conductor

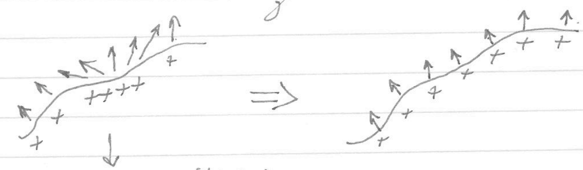
if  charges will move 

→ charges move until $\vec{E} \to 0$

B) for isolated conductors, all net charge distributed on its surface



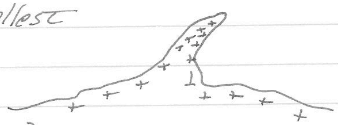
C) $\vec{E}$ is ⊥ to surface for points close to the surface



not equilibrium

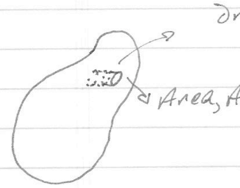
→ non-⊥ components of $\vec{E}$ will cause surface currents until they go away

D) for irregular shapes, charge density σ is a maximum where radius of curvature is smallest



What is E near surface?

draw cylinder near surface



→ E in endcap inside conductor = 0

→ E thru sides of cylinder = 0

→ E thru external end cap

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{q}{\epsilon_0}$$

⇓

$$EA = \sigma A / \epsilon_0 \Rightarrow \boxed{E = \sigma/\epsilon}$$