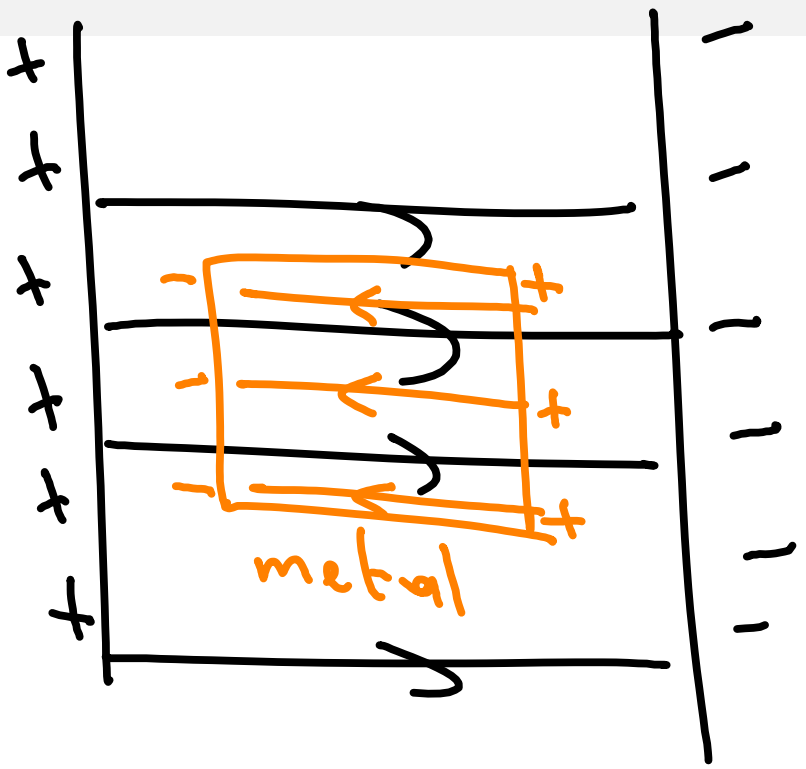
March 3, 2014

"There are no electric fields inside conductors"

CORRECT

WRONG!

"There are no electric fields in conductors in electrostatics"

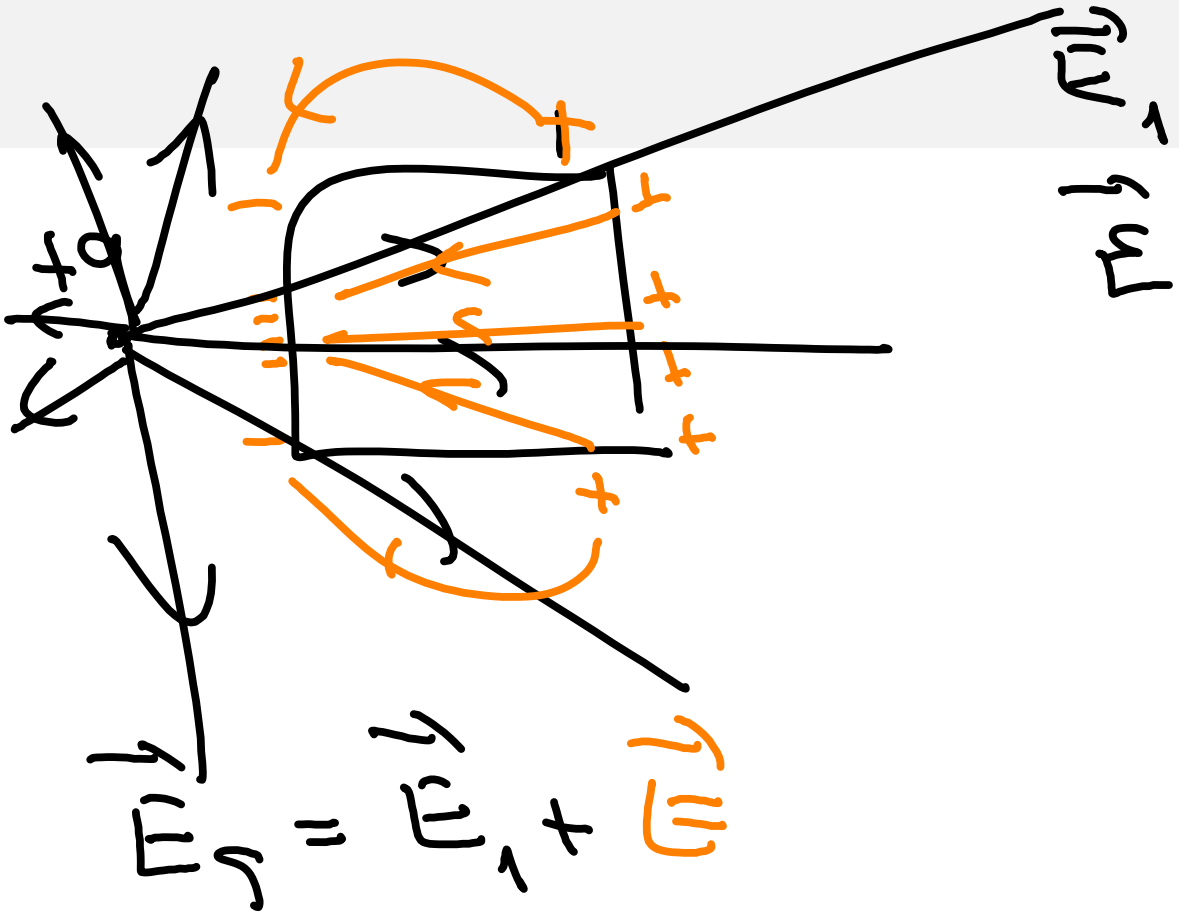


there will be a current until:

$$\vec{E} = -\vec{E}_{ext}$$

$$\vec{E}_T = \vec{E} + \vec{E}_{ext}$$

$$= 0$$

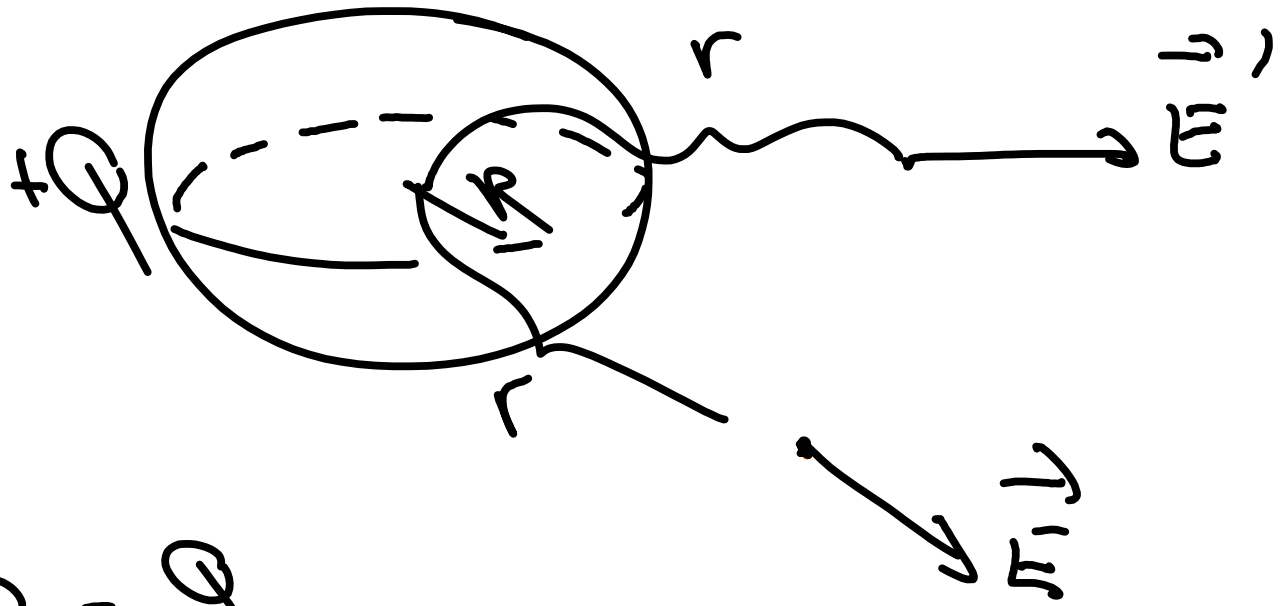


$\vec{E}_1$: electric field of point charge in the absence of the conductor

Gauss' Law

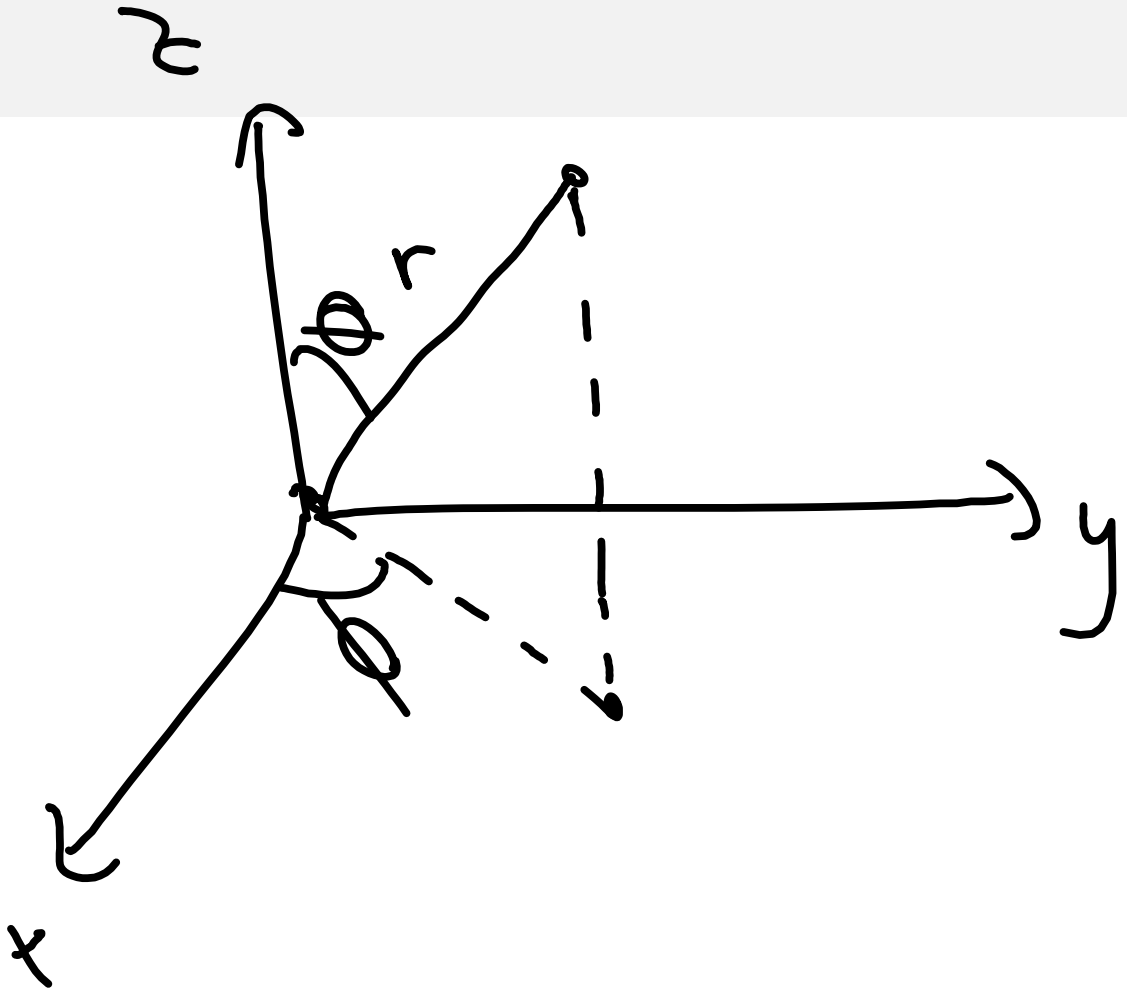
- $\vec{E}$ of a sphere
- $\vec{E}$ of an infinite plane
- charge density on the surface of a conducton

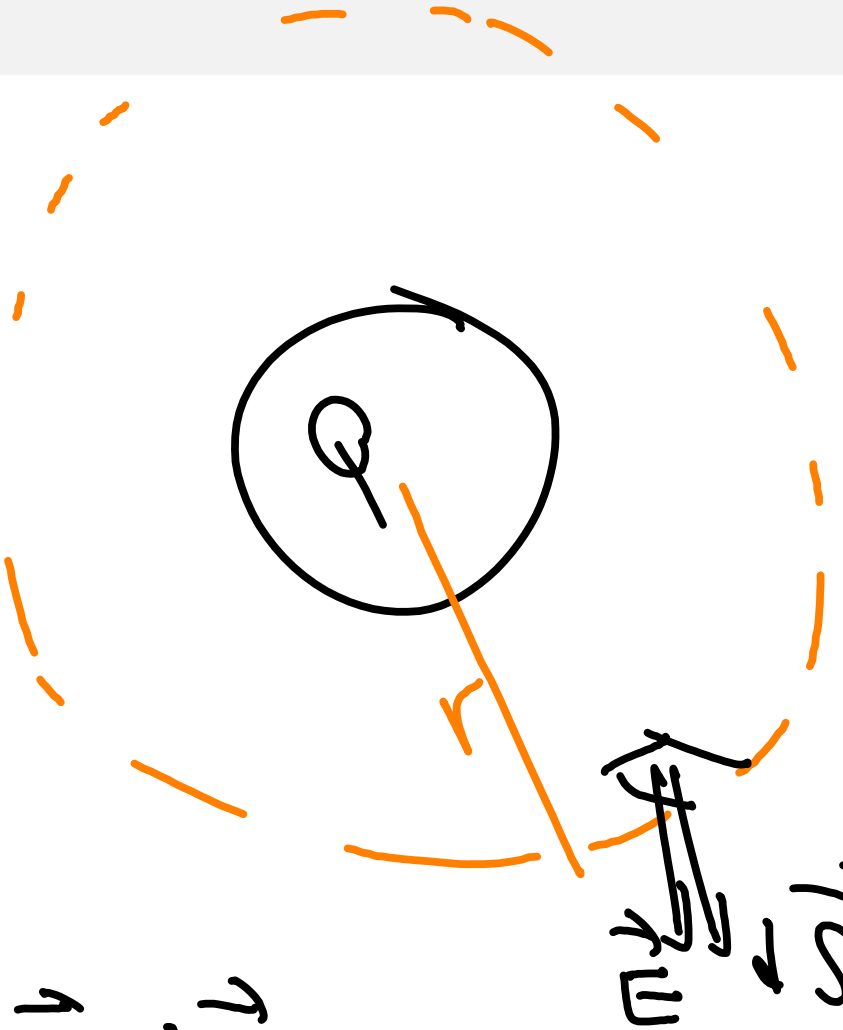
Ex $\quad \vec{E} = ?$ $\quad \vec{E} = E(r)\hat{r}$



$$\rho = \frac{Q}{\frac{4}{3}\pi R^3}$$

$$(\Delta q) = \rho\,(\Delta V)$$


z
r
θ
y
φ
x



$$\oint \vec{E} \cdot d\vec{S} = \frac{Q}{\varepsilon_0}$$

$$\vec{E} \cdot d\vec{S} = E\, dS$$

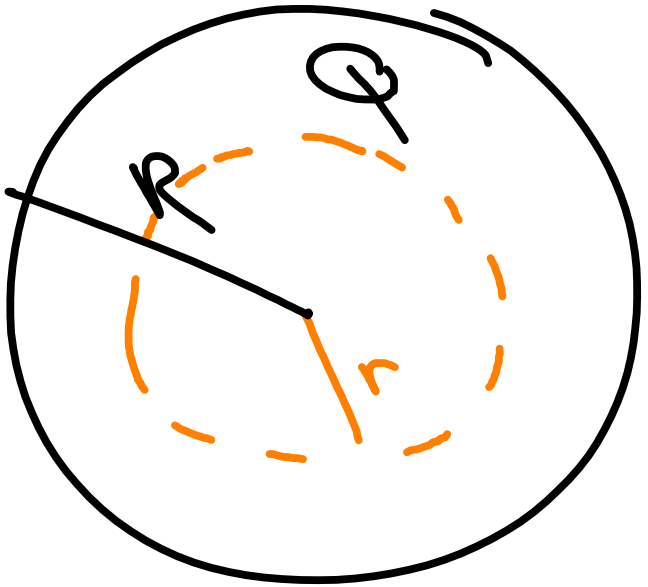
$$\frac{Q}{\varepsilon_0} = \oint E\, dS = E \oint dS$$

$$= 4\pi r^2 E$$

$$\Rightarrow E(r) = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2}$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} \hat{r}$$

$$\vec{E} = E(r)\,\hat{r}$$



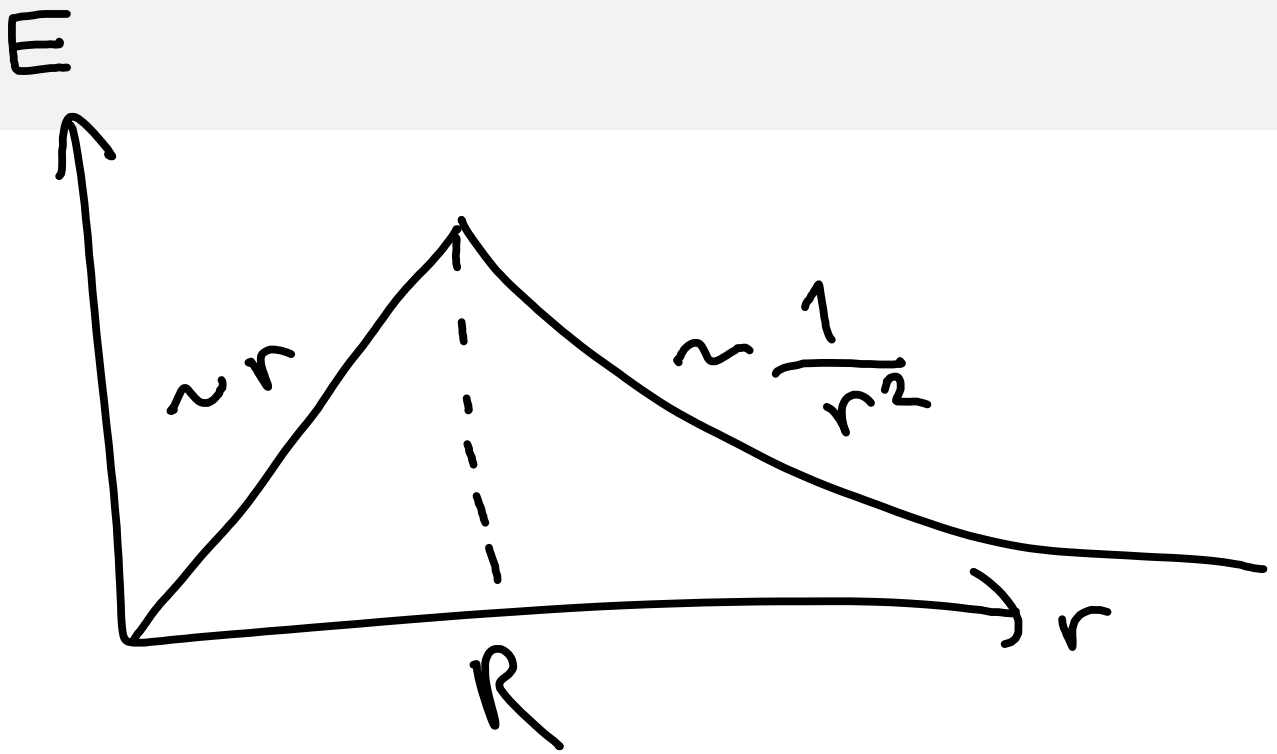
$$\oint \vec{E}\cdot d\vec{S} = \int E\, dS$$

$$= E\, 4\pi r^2 = \frac{4}{3}\pi r^3 \frac{\rho}{\varepsilon_0}$$

$$\Rightarrow \boxed{E = \frac{\rho}{3\varepsilon_0} r}$$

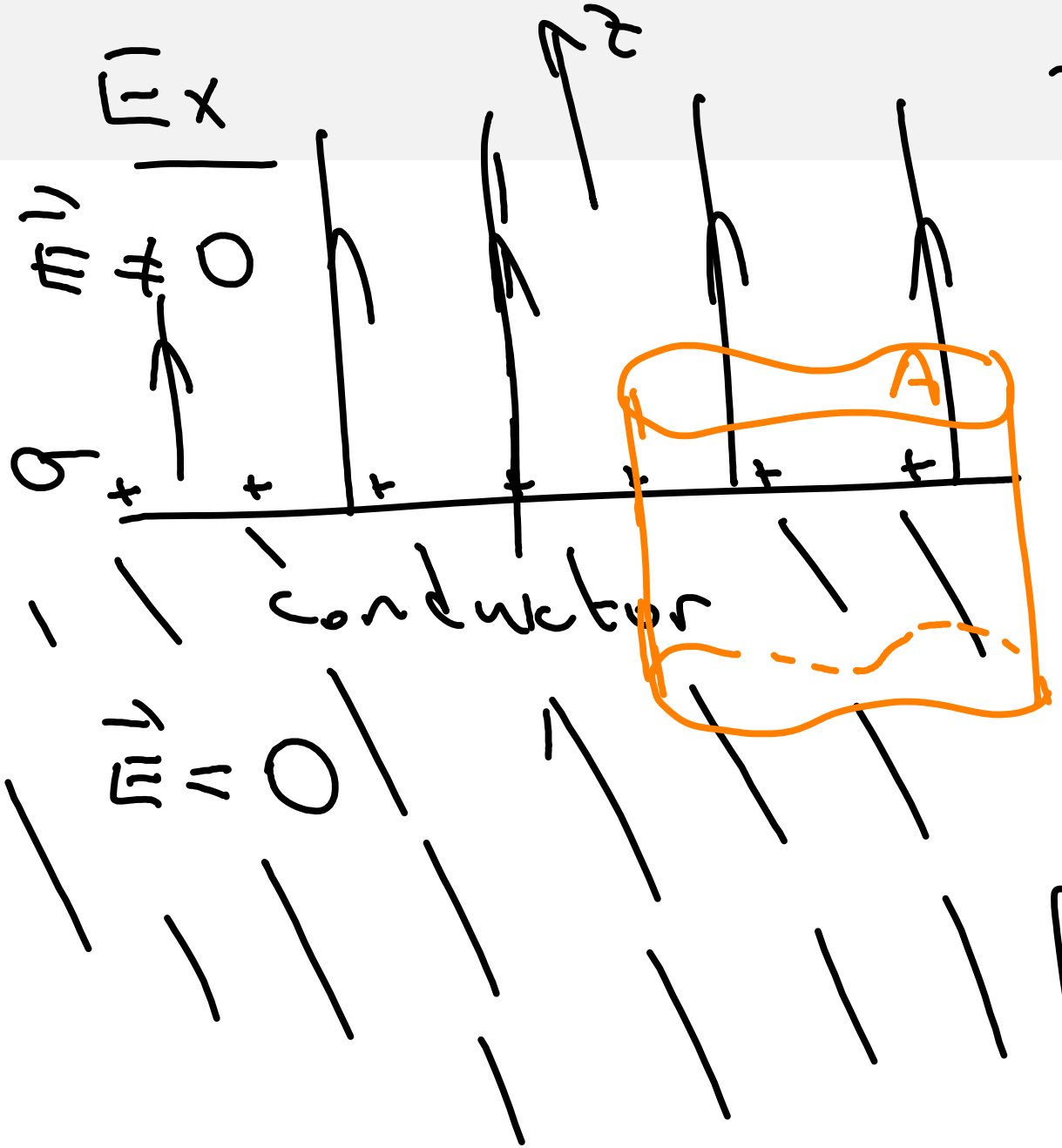
$$Q_{enc} = \rho \frac{4}{3}\pi r^3$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^3} r\,\hat{r} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^3} r\,\hat{r}$$


E
$\sim r$
$\sim \frac{1}{r^2}$
R
r

$$|\vec{F}_{gr}| = G_N \frac{m_1 m_2}{r^2}$$

$$|\vec{F}_{el}| = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$$



$$\vec{E} = E_0 \hat{z}$$

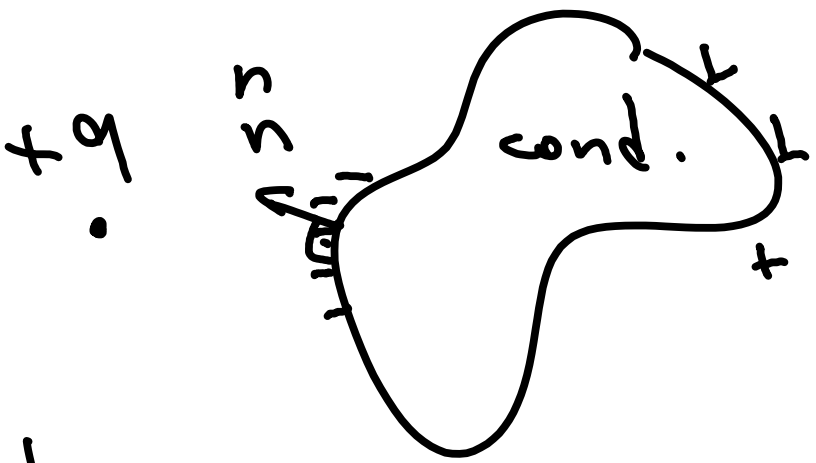
$$\oint \vec{E} \cdot d\vec{S} = \int_{top} \vec{E} \cdot d\vec{S}$$

$$= \int_{top} E_0 \, dS = E_0 A$$

$$E_0 A = \frac{\sigma A}{\varepsilon_0}$$

$$E_0 = \frac{\sigma}{\varepsilon_0}$$

Ex



if $\vec{E}$ is known, what is $\sigma(\vec{r})$?

σ : surface charge density.

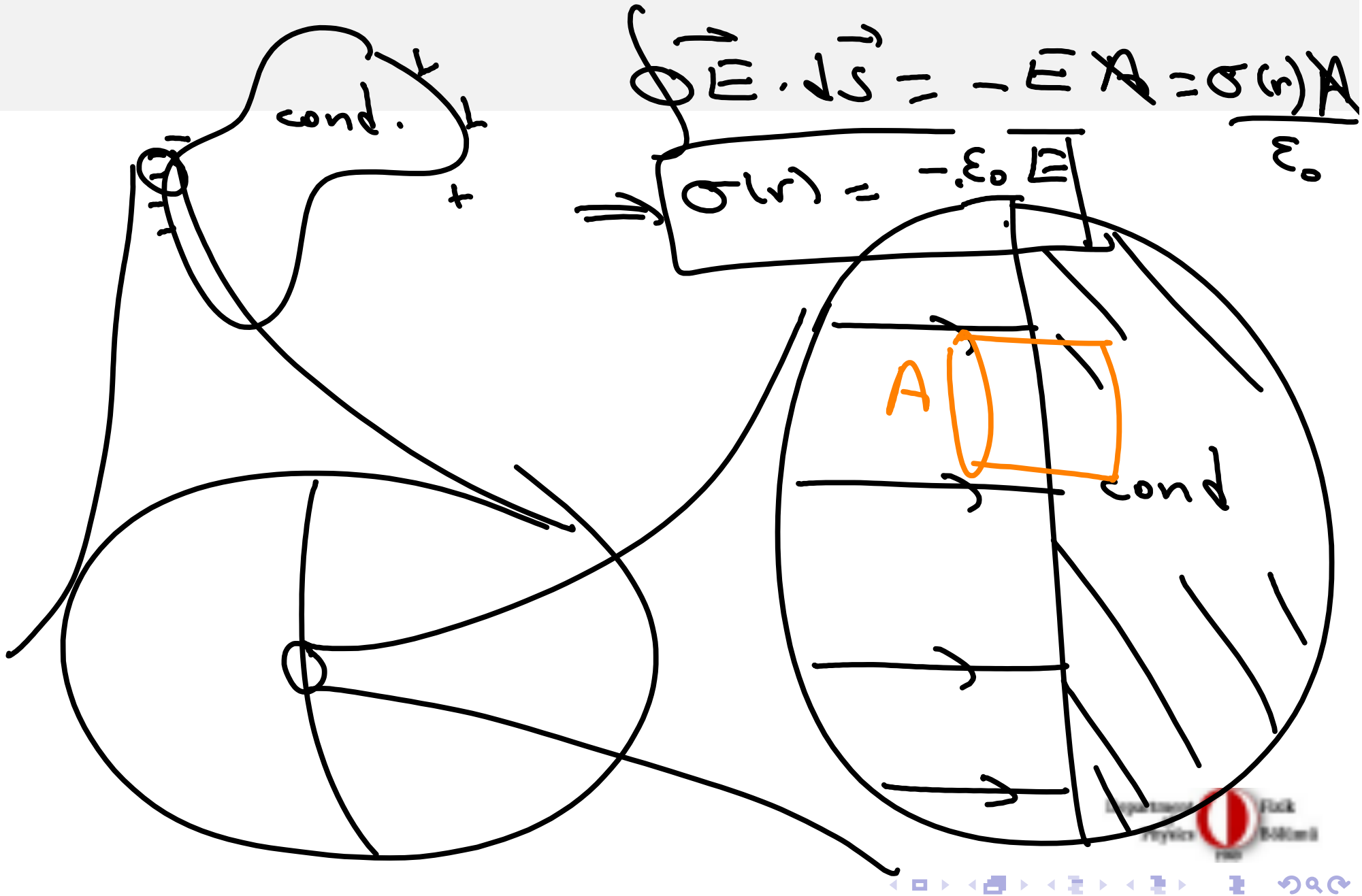
knowns

- Gauss' Law
- no electric field inside conductor
- $\vec{E}$ is perpendicular to the surface

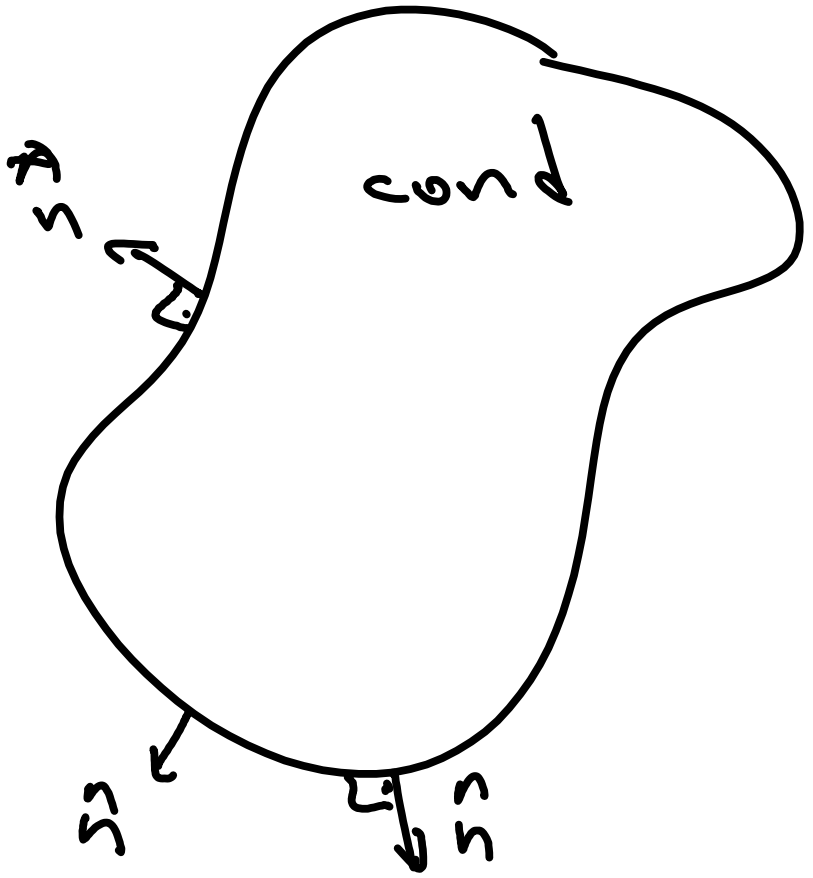
$$\sigma = \varepsilon_0 (\vec{E} \cdot \hat{n})$$

σ: charge on the surface

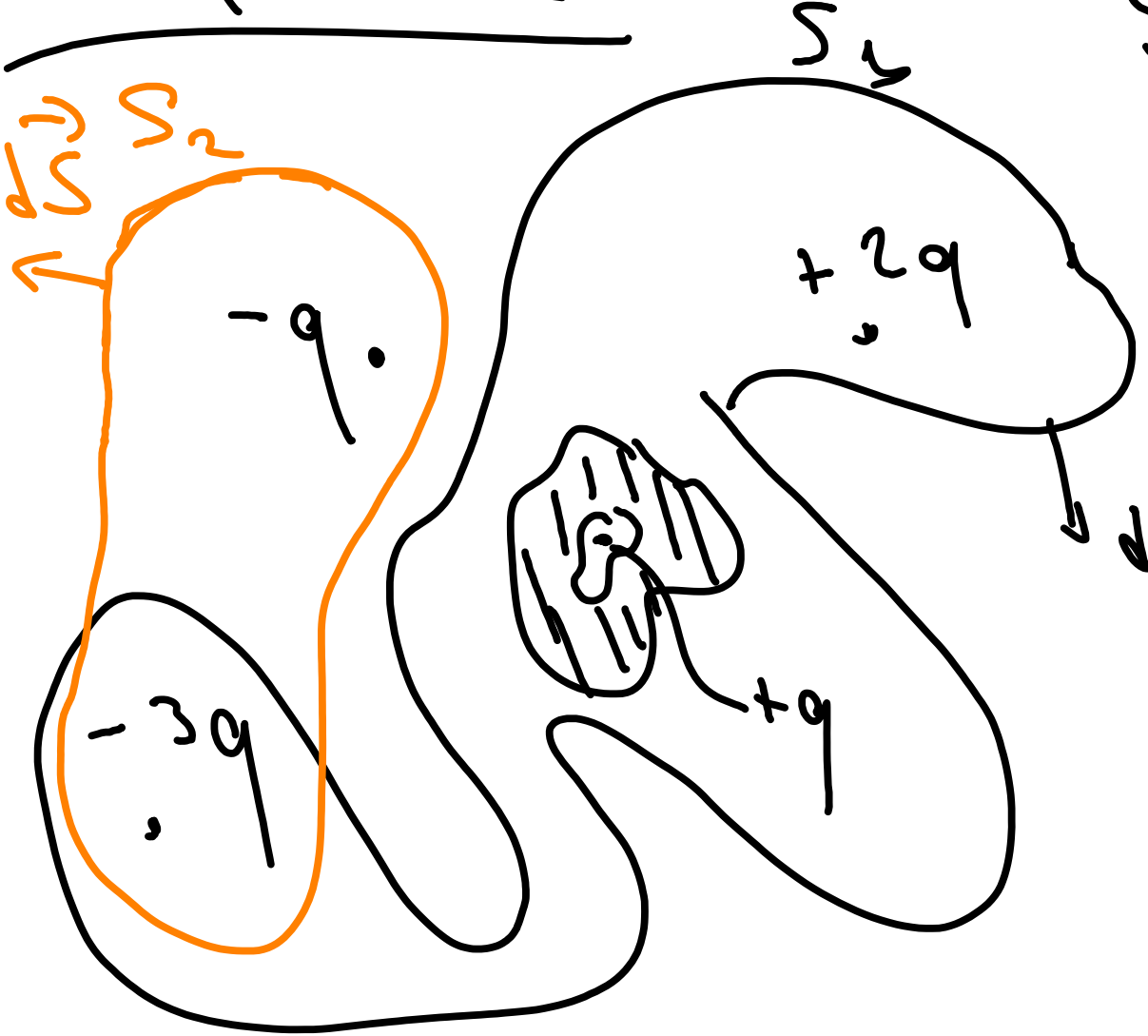
$\vec{E}$: electric field on the surface


cond.
$\oint \vec{E} \cdot d\vec{S} = -EA = \sigma(r)A/\varepsilon_0$
$\sigma(r) = -\varepsilon_0 E$
A
cond

$$\vec{E} \cdot \hat{n} = |\vec{E}|\,|\hat{n}| \cos\theta$$



QUIZ 1



$\oint \vec{E} \cdot d\vec{S} = ?$

a) for S_1

b) for S_2