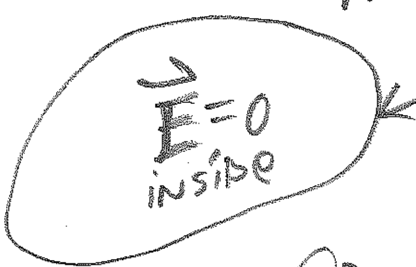
4B 2-10-14

sec 22.4 in detail Gauss's Law

MORE Applications beyond field of point charge and infinite line of charge (LAST time)

(A) conductor (SOLID) in electrostatic equilibrium:

(i) NEUTRAL conductor



$\vec{E}=0$ on surface

NOTE: $\vec{F}=m\vec{a}=0=q\vec{E}$.
$\vec{E}=0$.

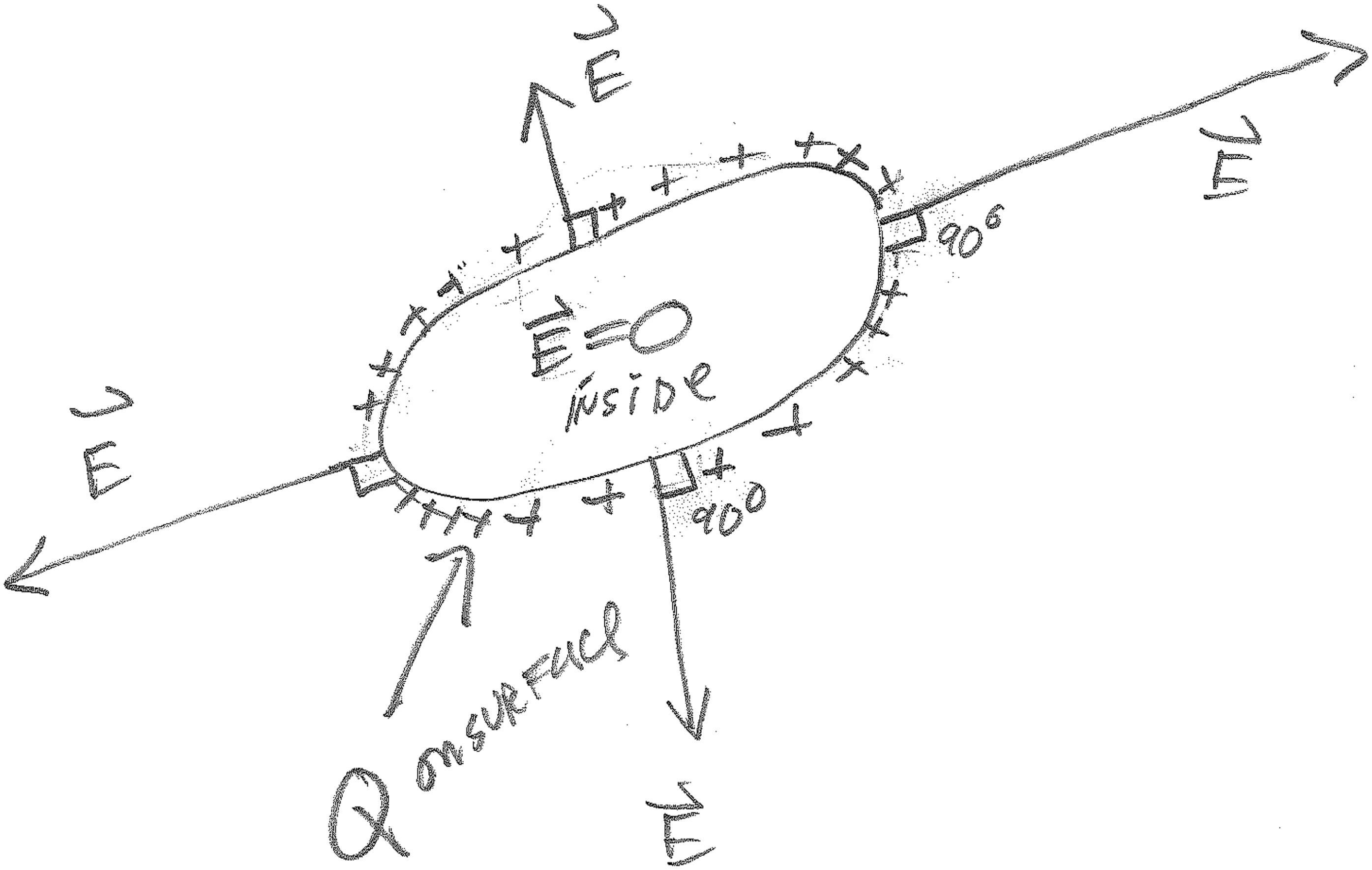
(ii) PUT excess charge Q inside conductor.

(a) charge finally resides on surface.

(b) $\vec{E}=0$ inside

(c) $\vec{E}\perp$ surface on surface

NOTE: $\perp$ means perpendicular to



EQUILIBRIUM:

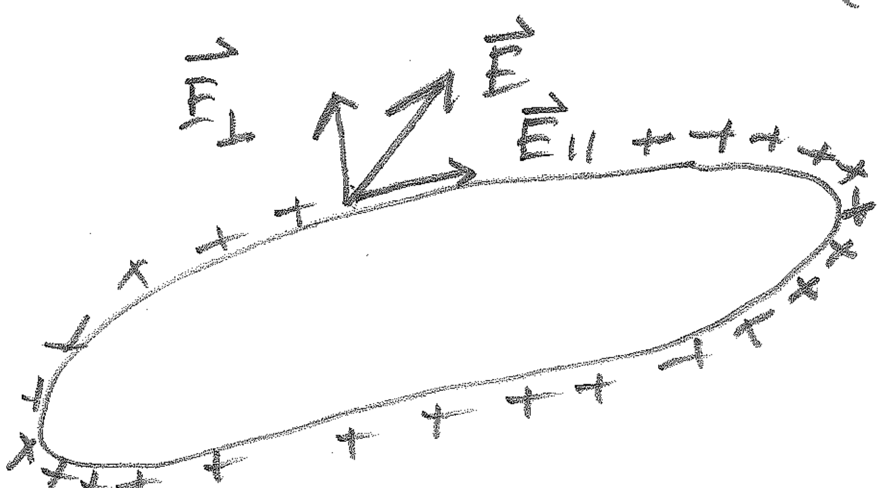
ALL CHARGE on and <u>inside</u> conductor at <u>REST</u>. THUS, $\vec{F} = q\vec{E} = 0 = m\vec{a}$. THUS, $\vec{E} = 0$ <u>INSIDE</u>. FOR any Gaussian surface <u>in side</u>, $\oint \vec{E}\cdot d\vec{A} = 0$.

THUS, $Q_{encl} = 0$ SINCE $\oint \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\varepsilon_0}$.

NOTE: $\vec{E}\cdot d\vec{A} = E\,dA\cos\theta$

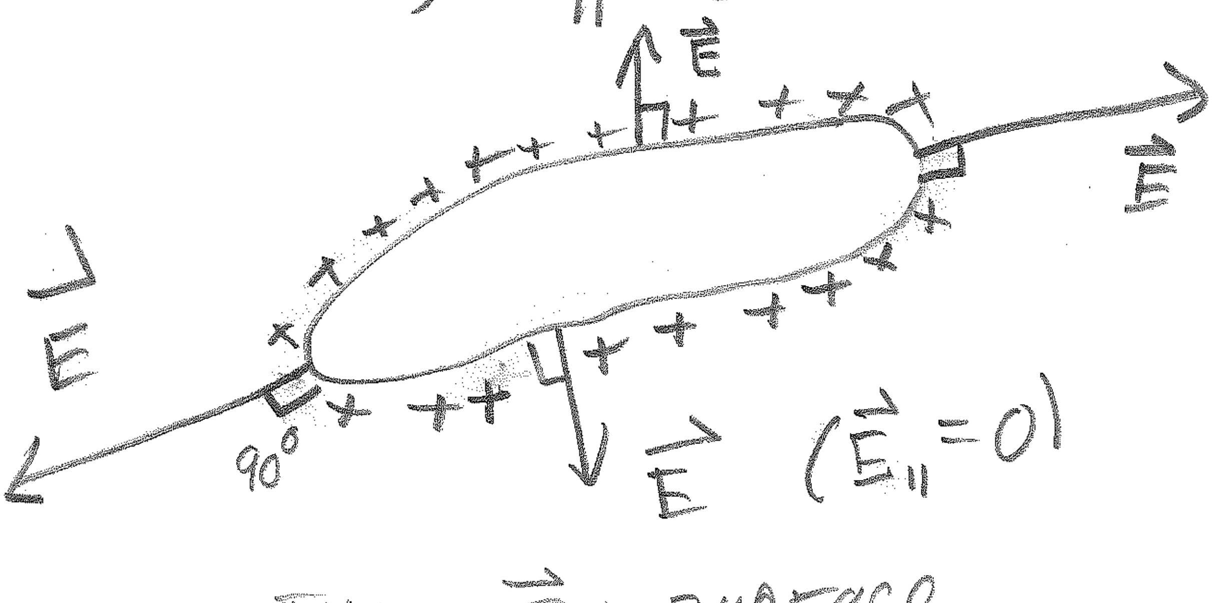
THUS, all CHARGE <u>on</u> <u>SURFACE</u>.

NOW LOOK at SURFACE:



SINCE CHARGES at REST on SURFACE, $\vec{F}_\parallel = q\vec{E}_\parallel = 0$.

THUS, $\vec{E}_\parallel = 0$.

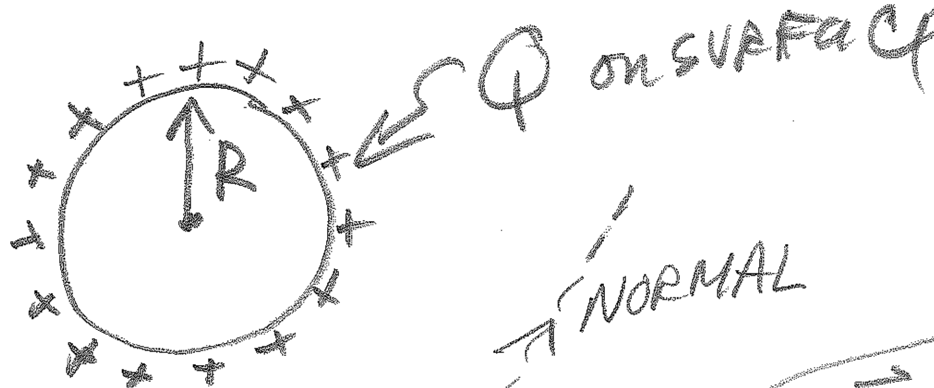


THUS, $\vec{E} \perp$ SURFACE.
perpendicular to

B. EXAMPLE 22.5

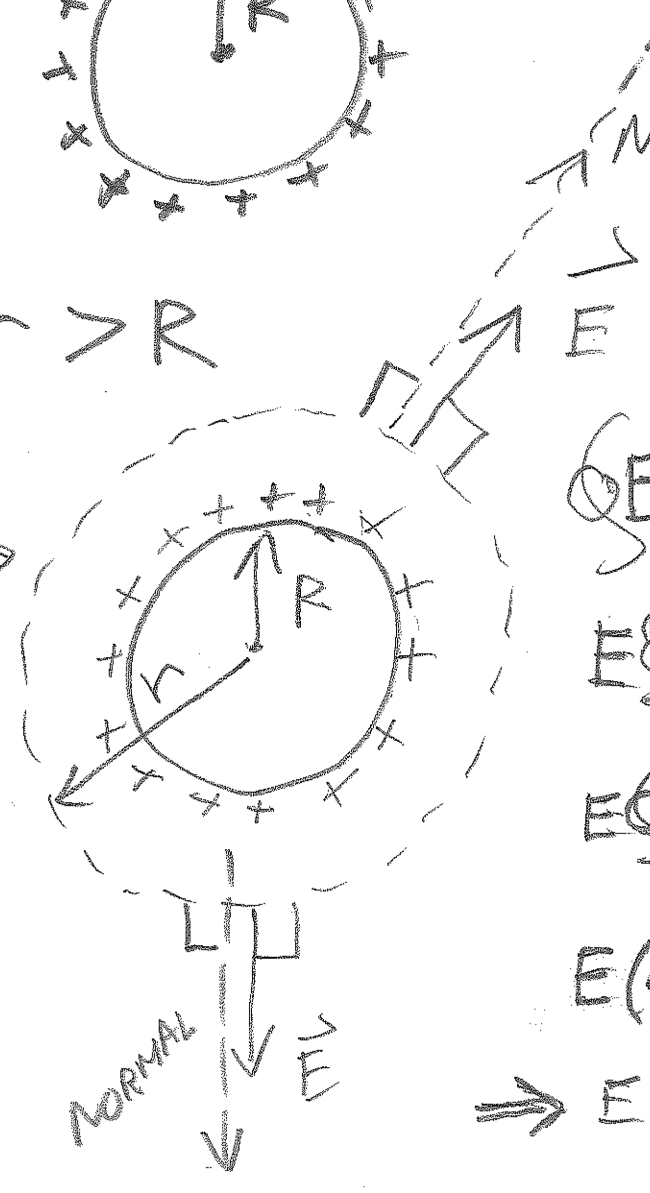
charged conducting sphere:

FIND $\vec{E}$ INSIDE and OUTSIDE.



(i) $r > R$

G.S.



NOTE: $\vec{E} \cdot d\vec{A} = E\,dA\cos\theta$

$$\oint_{GS} E\,dA\cos\theta = \frac{Q_{encl}}{\varepsilon_0}$$

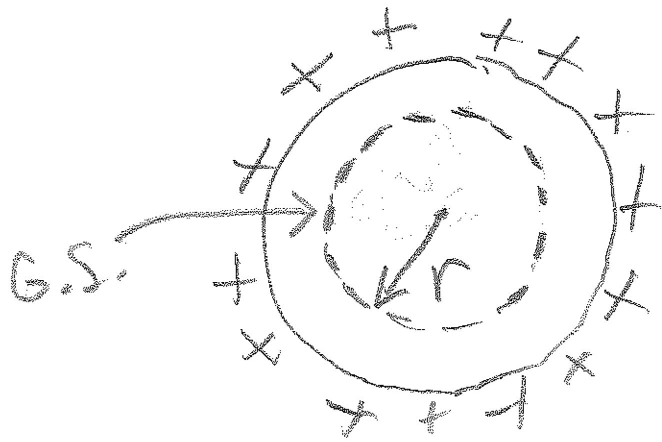
$$E \oint dA\cos 0 = \frac{Q}{\varepsilon_0}$$

$$E \oint dA = \frac{Q}{\varepsilon_0}$$

$$E(4\pi r^2) = Q/\varepsilon_0$$

$$\Rightarrow E = \frac{Q}{4\pi\varepsilon_0 r^2}, \quad r > R$$

(ii) $r < R$



$$\oint_{GS} E\,dA\cos\theta = \frac{Q_{encl}}{\varepsilon_0}$$

$Q_{encl} = 0$ since
ALL CHARGE ON SURFACE $\therefore$

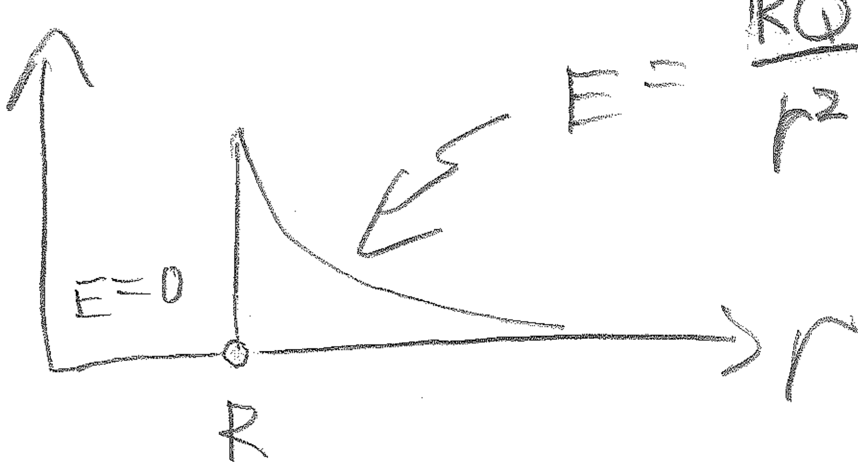
$$\oint E\,dA\cos\theta = 0$$

$$E(4\pi r^2) = 0$$

$$\Rightarrow E = 0,\ r < R$$

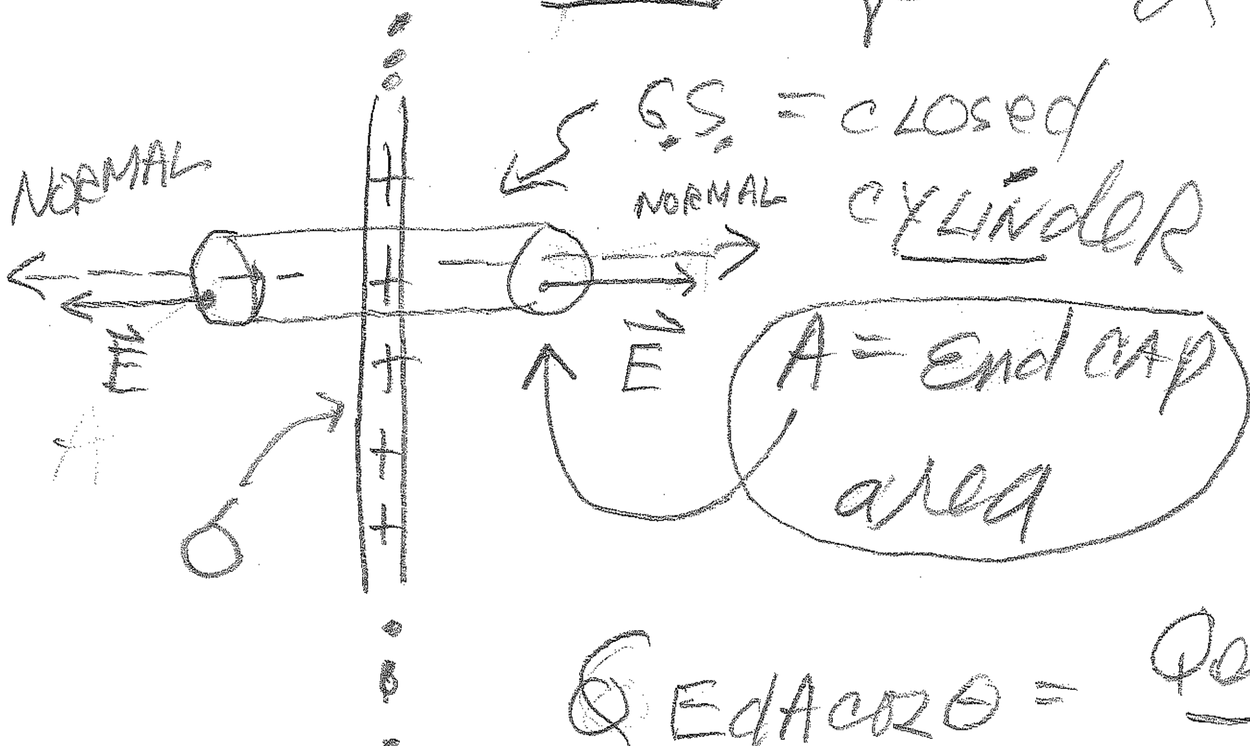
$E = |\vec{E}|$

$$E = \frac{kQ}{r^2},\ k = \frac{1}{4\pi\varepsilon_0}$$

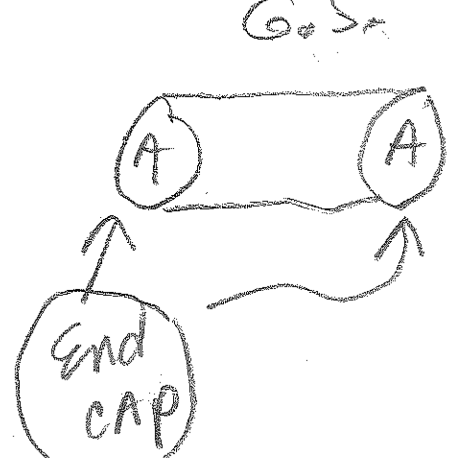


(C.) Example 22.7:

Field of an infinite sheet of charge:



$$\oint E\,dA\cos\theta = \frac{Q_{encl}}{\varepsilon_0}$$



$$Q_{encl} = \sigma \cdot A$$

$$\int\limits_{\text{End caps}} E\,dA\cos\theta = \frac{\sigma A}{\varepsilon_0}$$

$$EA + EA = \frac{\sigma A}{\varepsilon_0}$$

$$\rightarrow E = \frac{\sigma}{2\varepsilon_0}$$ like Ch 21!