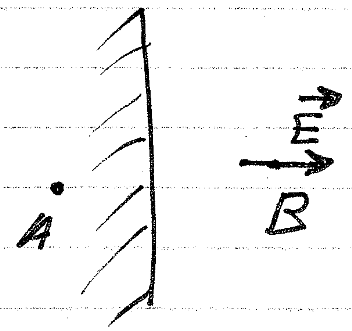
① Phys 1402 2015-09-03 Lec 3



A metal plate has an electric field near it. $E = 1000$ N/C at point B.

What charges do we know about?

- There is some ⊕ charge on the metal.
- If $\vec{E} \neq 0$ @ A, charges would move and gather somewhere until they cancel $\vec{E}$. (@ A)
- $\vec{E} = 0$ in a conductor.
- If we measure $\vec{E}$ along a line from A to B, $\vec{E}$ would jump from 0 to 1000 N/C @ the surface.

E jumps by $4\pi k\sigma$ @ a surface.

- $4\pi k\sigma = (1000\ \text{N/C})$

$$\sigma = \frac{1}{4\pi k}(1000\ \text{N/C}) = 8.85\times10^{-9}\ \text{C/m}^2$$

- There are ~9 nC/m^2 on the surface.

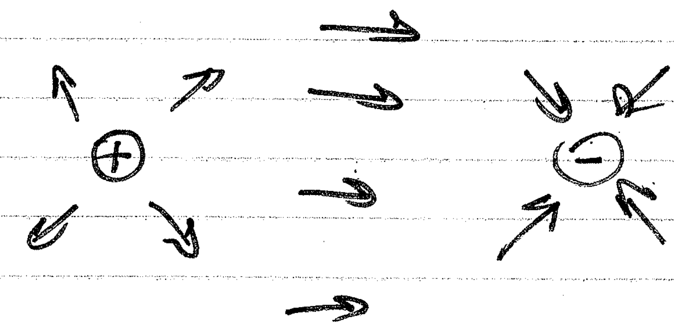
(2)

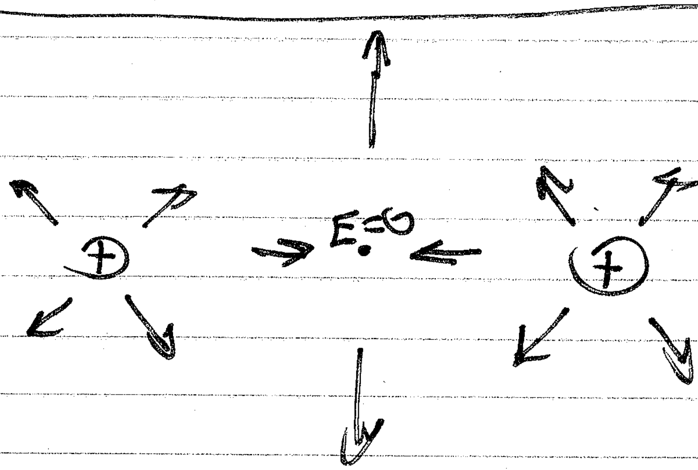
E fields:

- point charge $E = \frac{kQ_s}{r^2}$ (away from $\oplus$)
- surface $E = 2\pi k\sigma$ (away from $\oplus$)

Notice E is always away from $\oplus$
We can think of $\vec{E}$ as the "flow" of something called electric flux.

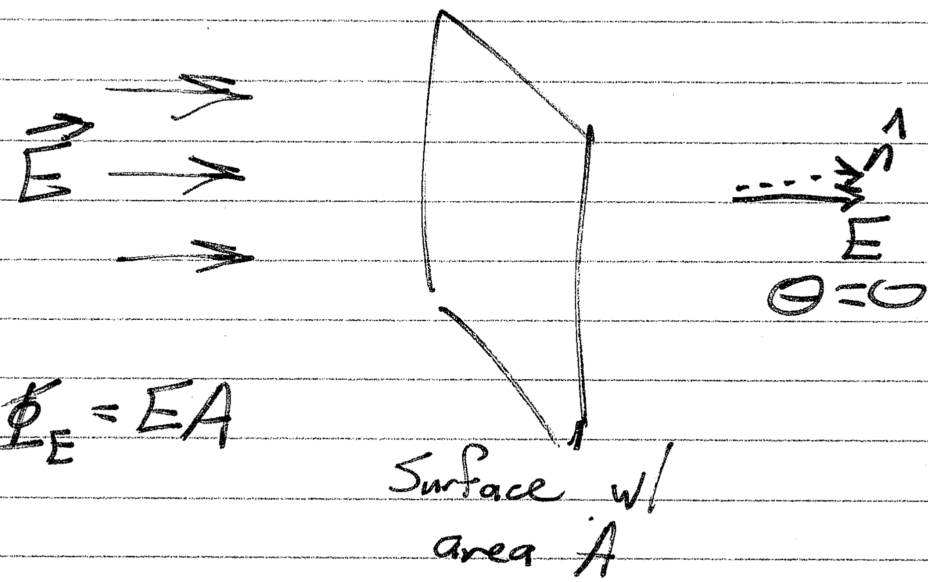
$\oplus$ charges generate Φ_E
$\ominus$ charges sink Φ_E





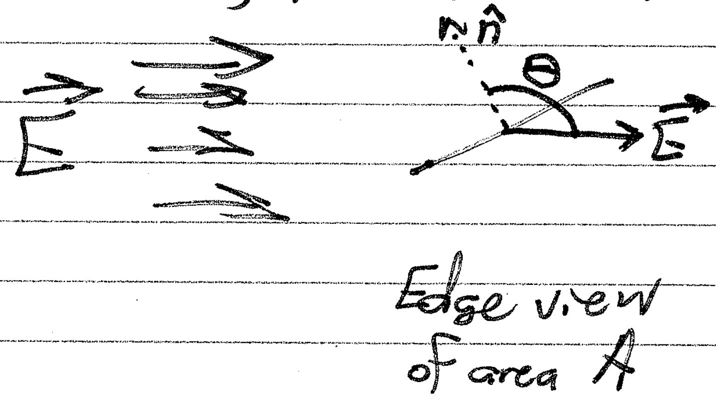
Electric Flux is

$$\Phi_E = \vec{E}_{avg} \cdot \vec{A}$$



$\Phi_E = EA$

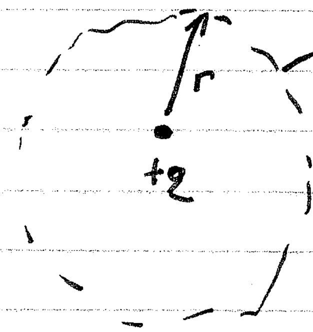
Twisting the surface "catches" less Φ_E.



$\Phi = EA \cos\theta$

Flux due to a charge - Gauss's Law

$$\Phi_E = \frac{Q}{\varepsilon_0} = 4\pi k Q$$



Φ going thru surface is $4\pi k Q$

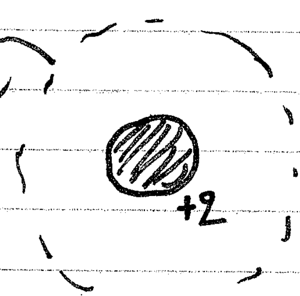
$$E A = \Phi_E = 4\pi k q$$

$A = 4\pi r^2$

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

$$E = \frac{kq}{r^2}$$

Gaussian Surface

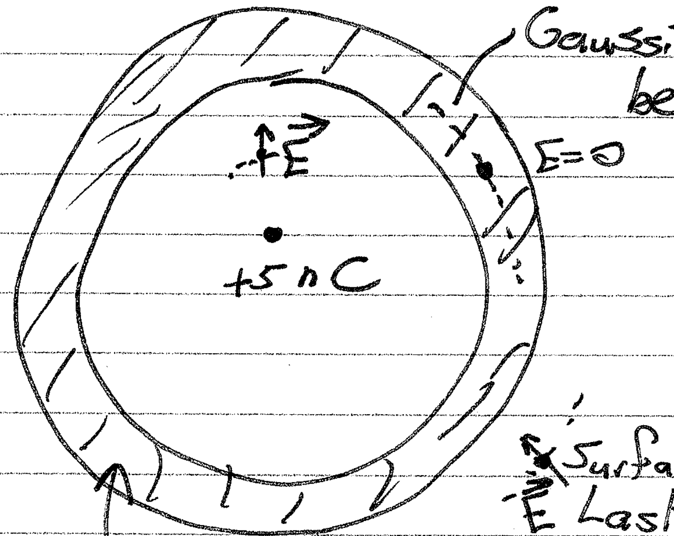


$E = \frac{kq}{r^2}$ ← inside our shell

r = dist from center

Spherical symmetry

(5)



$\Phi_E = E A$
$= 0$
$Q_{enc} = 0$

List of charges
- +5 nC
- q_{inner}
- q_{outer}

$q_{inner} + 5nC = 0$ ($q_{inner} = -5nC$)

$q_{in} + q_{out} = -15nC$ ($q_{out} = -10nC$)

Outside the sphere Q_{enc} = everything

$$E = \frac{kQ_{enc}}{r^2} = \frac{k(-10\,nC)}{r^2}$$

(6) Model: Electric Potential (ch 16)

Phys I	Phys II
Force $= \vec{F}$	$\vec{E} = \vec{F}/q_0$
$W = \vec{F} \cdot \Delta\vec{r}$	$\frac{W}{q_0} = \vec{E} \cdot d\vec{r}$
$\Delta U = -W = -\vec{F} \cdot \Delta\vec{r}$	$\frac{\Delta U}{q_0} = -\vec{E} \cdot d\vec{r}$ ← $\Delta\vec{r}$
$U = mgy$	$\frac{U}{q_0} = V = -E \cdot x$
Gravity points down toward low U.	$\vec{E}$ points "down" toward low V.

Many names for V:

- Electric Potential
- Potential Difference
- Voltage
- Electromotive Force

$\vec{E}$ is

- Force per charge
- Flow of Flux
- "Downhill" of voltage landscape