Conductors in Electrostatic Equilibrium

A cynic is a man who, when he smells the flowers, looks around for a coffin. *H.L. Mencken*

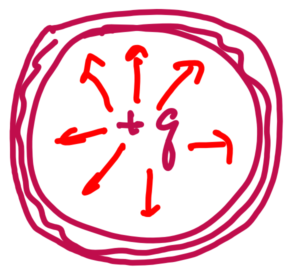
Electrostatic Equilibrium

$\oint E \cdot dA = \frac{q_{in}}{\epsilon_0}$

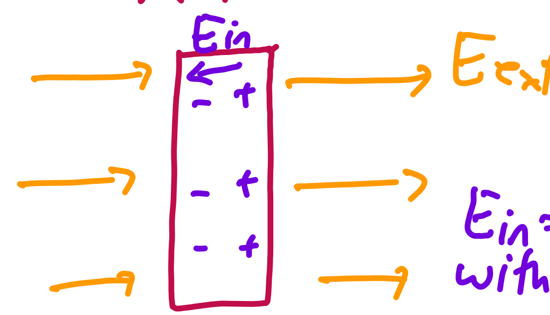
- **A conductor in electrostatic equilibrium** has the following properties:

1. The E-field is __0__ everywhere inside the conductor.
2. If an isolated conductor carries a net charge, the charge resides on its __surface__.
3. The E-field just outside a charge conductor is __⊥__ to the surface of the conductor and has a magnitude of σ/ϵ_0 , where σ is the surface charge density at that point.
4. On an irregularly shaped conductor, the surface charge density is greatest at locations where the radius of curvature of the surface is __smallest__.

1. The E-field is zero everywhere inside the conductor. If $E \neq 0 \Rightarrow F \neq 0 \Rightarrow q$ move $\Rightarrow$ not equilibrium $\therefore E = 0$

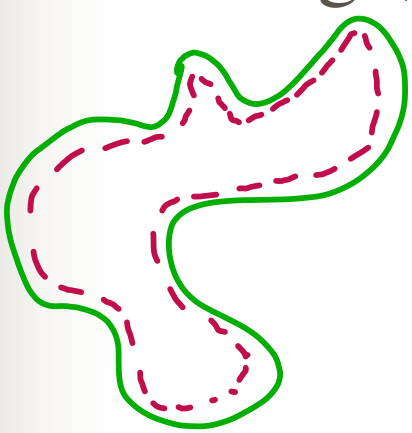


ex



$E_{in} = E_{ext}$ within slab
$E_{TOT} = 0$

2. If an isolated conductor carries a net charge, the charge resides on its surface.



3-D physical surface

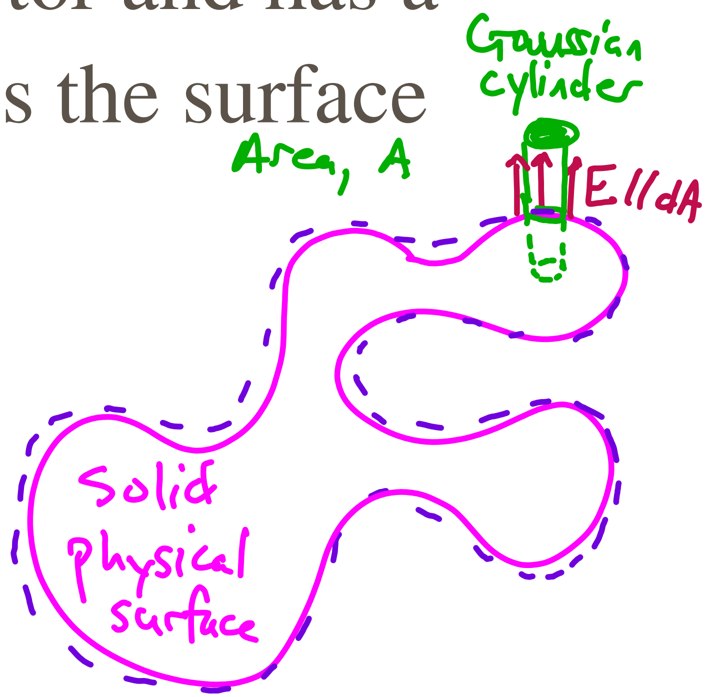
A) Take Gaussian surface just inside physical surface
B) $E = 0$ due to #1
C) If $E = 0$ then $q_{in} = 0$
D) Excess q must be on surface.

3. The E-field just outside a charge conductor is $\perp$ to the surface of the conductor and has a magnitude of σ/ϵ_o , where σ is the surface charge density at that point.

$$\oint E \cdot dA = \frac{q_{in}}{\epsilon_o}$$

$$E(A) = \frac{\sigma A}{\epsilon_o}$$

$$\boxed{E = \frac{\sigma}{\epsilon_o}}$$



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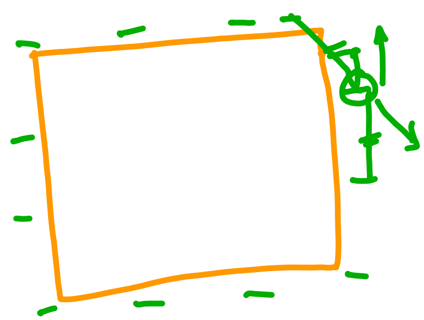


distribution is greater @ sharper

Example

A solid conducting sphere of radius a carries a net positive charge $2Q$. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere and carries a net charge $-Q$. Find the E-field for the following radii

a) $r < a$

b) $a < r < b$

c) $b < r < c$

d) $r > c$

e) *What amount of charge exists on each surface?*

f) *What is the charge density on each surface?*

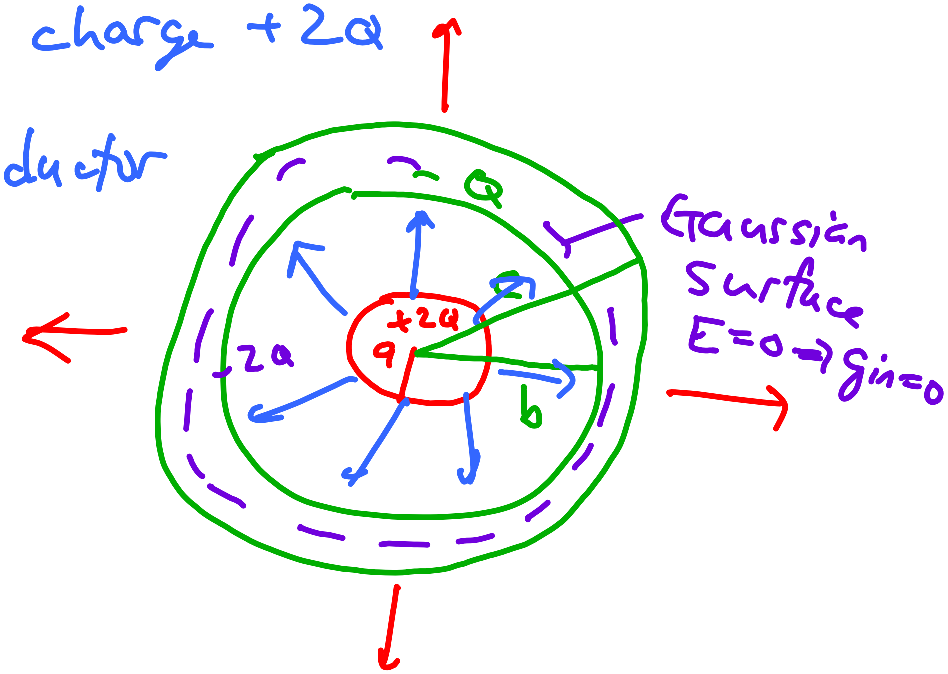
a) $r < a$, $E = 0$, inside conductor

b) $a < r < b$, $E = \frac{2KQ}{r^2}$, point charge $+2Q$

c) $b < r < c$, $E = 0$, inside conductor

d) $r > c$, $E = \frac{K(2Q - Q)}{r^2}$

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



e) @ a, $+2Q$

@ b, $-2Q$

@ c, $+Q$

f) $\sigma = \frac{Q}{A}$