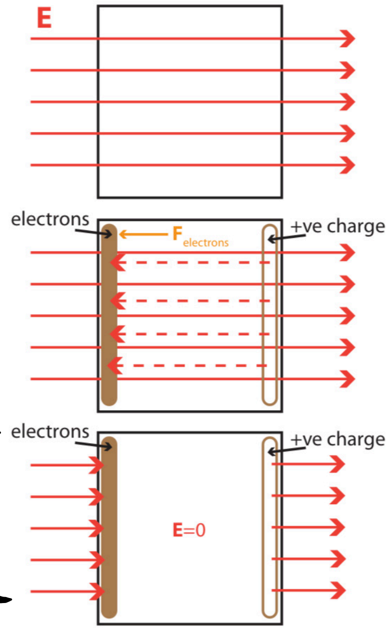
A conductor contains freely moving charged particles, an insulator does not.



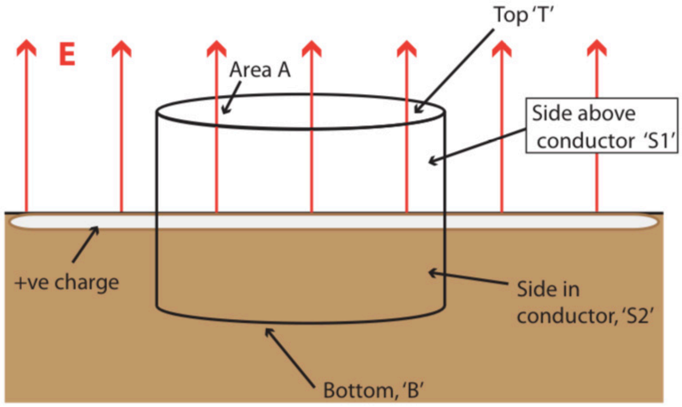
In static situations, the electric field $\underline{E}$ is zero inside the conductor.

Applying the field makes the e^- move to the left, these form their own $\underline{E}$ field which cancels with the external field.

Inside the conductor $\underline{E}$ is zero, the surface is also an equipotential & the electric field lines lie perpendicular to the surface.

Surface Charge

Consider the volume half-inside & half-outside a conductor. Applying gauss' law...



$\underline{E}=0$ $\quad$ $d\underline{s} \perp \underline{E}$

$$\oint \underline{E}\cdot d\underline{s} = \iint_T \underline{E}\cdot d\underline{s} + \cancel{\iint_B \underline{E}\cdot d\underline{s}}^{\,0} + \cancel{\iint_{S_1} \underline{E}\cdot d\underline{s}}^{\,0} + \cancel{\iint_{S_2} \underline{E}\cdot d\underline{s}}^{\,0}$$

$$= EA$$

The volume contains a total charge of σA so

$$E = \frac{\sigma}{\epsilon_0}$$ surface charge

Now if we shrink the area A to dA we can apply this to a sphere. The surface charge σ will be

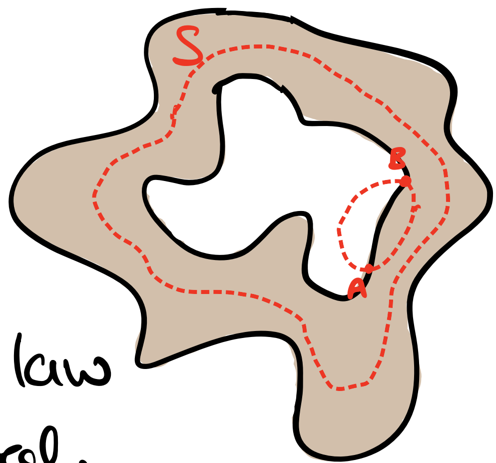
$$\sigma = \frac{Q}{4\pi a^2} \qquad (a\text{-radius})$$

Inserting this into $E = \frac{\sigma}{\epsilon_0}$ gives

$$E = \frac{Q}{4\pi\epsilon_0 a^2}$$

Electrostatic Shielding

Inside an empty, arbitrarily shaped cavity in a conductor the electric field is zero, $\underline{E} = 0$.



Consider the closed surface S inside the conductor, as in the conductor $\underline{E} = 0$, the via gauss' law there will be no charge enclosed.

$\therefore$ The inner surface will have no net charge. However, maybe the charge is just distributed and just sums to zero.

Looking at the smaller line integral,

$$\oint \underline{E} \cdot d\underline{l} = \cancel{\int_A^B \underline{E} \cdot d\underline{l}}^{\,0} + \int_B^A \underline{E} \cdot d\underline{l} = 0$$

it will be zero via gauss' law. The part inside the conductor will be zero. This implies that

$$\int_B^A \underline{E} \cdot d\underline{l} = 0 \quad \Rightarrow \underline{E} = 0$$

This means there is no electric field in the cavity. This is often called a Faraday Cage.