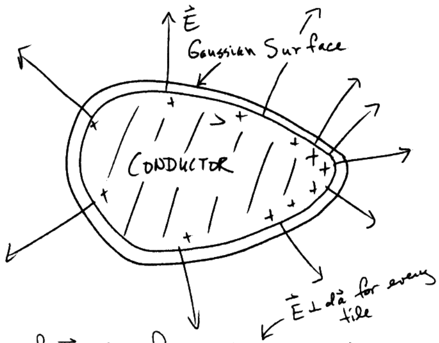
Gauss's Law always works. It is just hard to apply in non symmetric cases.



$\oint \vec{E}\cdot d\vec{a} = \oint |\vec{E}||d\vec{a}|\cos\phi = EA$ ← area of object

$= \dfrac{Q_{encl}}{\epsilon_0} = \dfrac{\bar{\sigma}}{\epsilon_0} \Rightarrow E = \dfrac{\bar{\sigma}}{\epsilon_0}$ near surface

where $\bar{\sigma}$ is the average σ over the surface

$\oint \vec{E}\cdot d\vec{a} = \int |\vec{E}||d\vec{a}|\cos\phi$ for all tiles

However $|\vec{E}|$ is NOT the same for all tiles and so it ~~cannot~~ be pulled outside the integral.

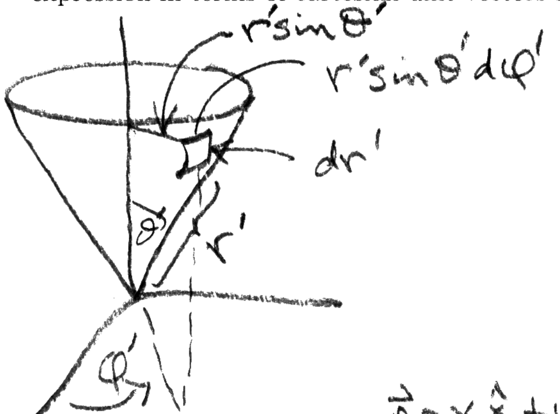
$\int E\,da \rightarrow \sum_i E_i \Delta a_i \neq E \sum_i \Delta a_i$

$Q_{enclose} = \int \sigma\, da = \bar{\sigma} A$ is ok

NAME

1. Charge is placed on the odd shaped conductor as shown. Explain above why there is or is not anything wrong with the Gauss's law derivation to get E shown.

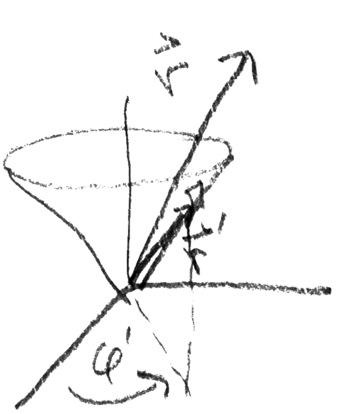
2. A uniform surface charge density, σ is placed on a the surface of a cone with apex at the origin and opening symmetrically on the z-axis. (a) Derive an expression for dq on the cone. (b) Derive an expression in terms of cartesian unit vectors for $\vec{r} - \vec{r}'$ for arbitrary location of $\vec{r}$.



$da = r'\sin\theta' d\varphi' dr'$

$dq = \sigma\, da$

$\vec{r} = x\hat{x} + y\hat{y} + z\hat{z}$



$\vec{r}' = r'\hat{r} = r'(r'\sin\theta'\cos\varphi'\hat{x} + r'\sin\theta'\cos\varphi'\hat{y} + \cos\theta'\hat{z})$

$\vec{\eta} = \vec{r} - \vec{r}'$