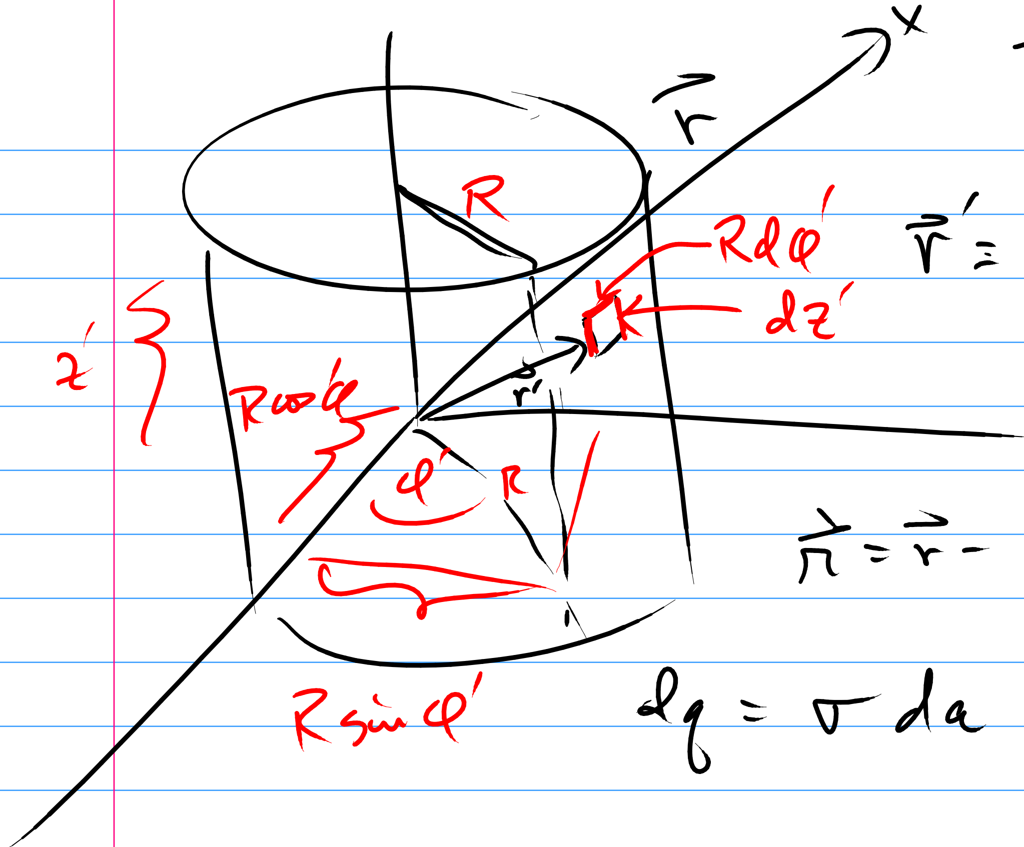


$$\vec{r} = x\hat{x} + y\hat{y} + z\hat{z}$$

$$\vec{r}\,' = R\cos\varphi'\hat{x} + R\sin\varphi'\hat{y} + z'\hat{z}$$

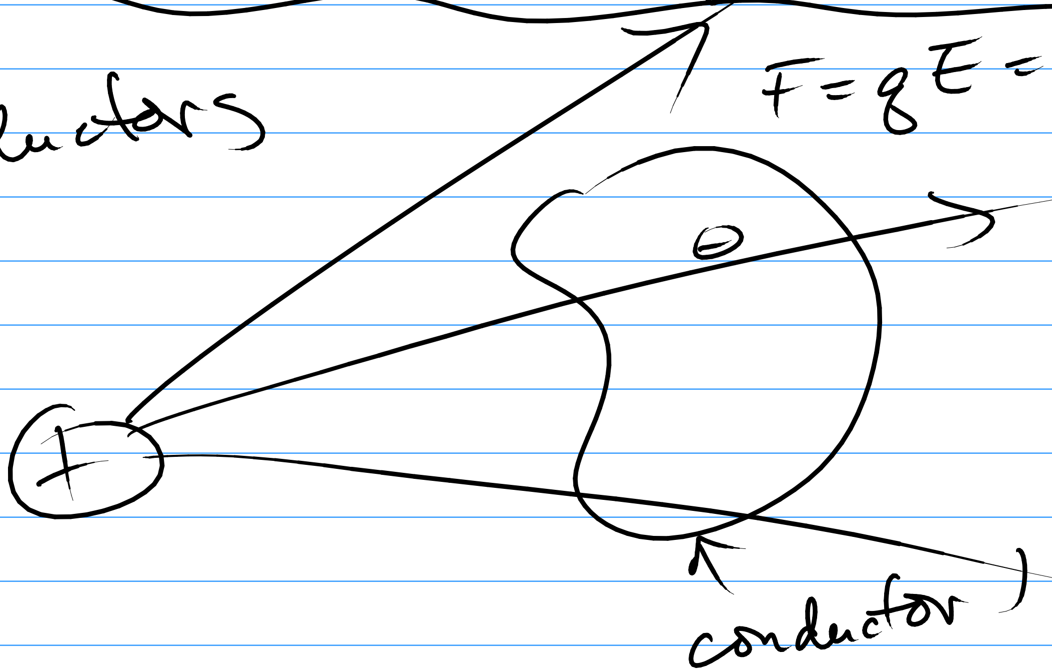
$$\vec{\mathscr{r}} = \vec{r} - \vec{r}\,'$$

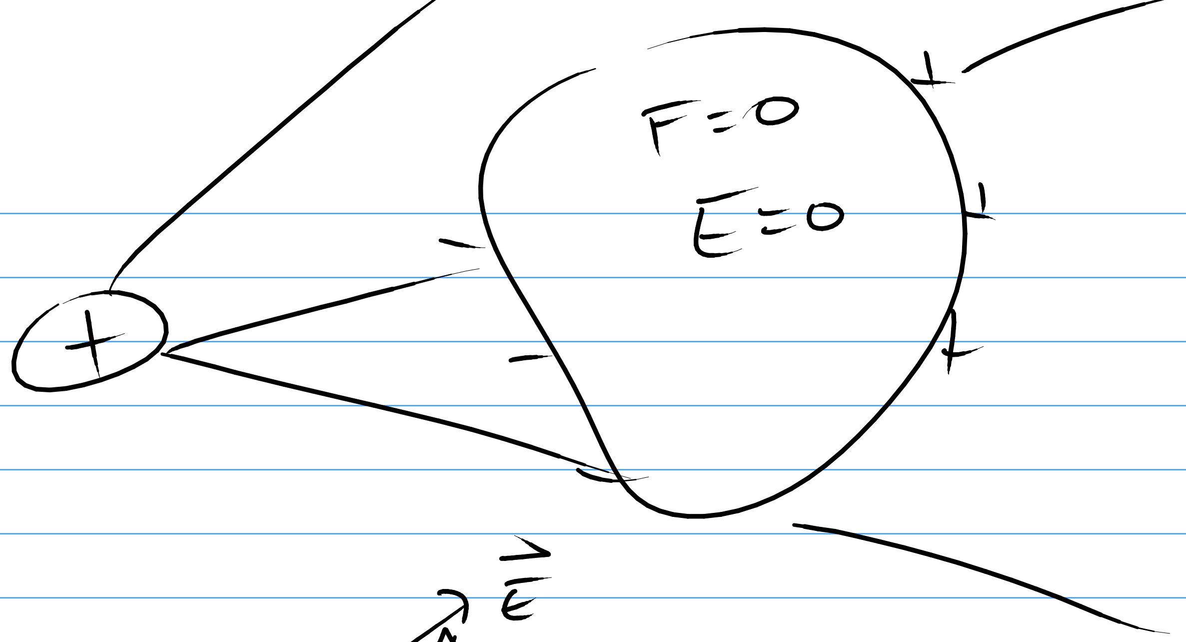
$$dq = \sigma\, da = \sigma R\, d\varphi'\, dz'$$

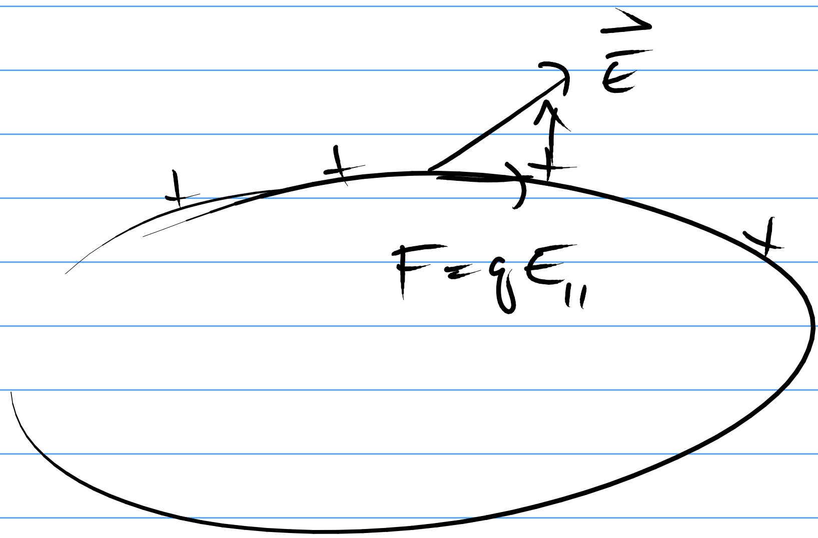
$$V = \frac{1}{4\pi\epsilon_0}\int \frac{dq}{\mathscr{r}} = \frac{1}{4\pi\epsilon_0}\int_0^H\int_0^{2\pi} \frac{\sigma R\, d\varphi'\, dz'}{|\vec{\mathscr{r}}|}$$

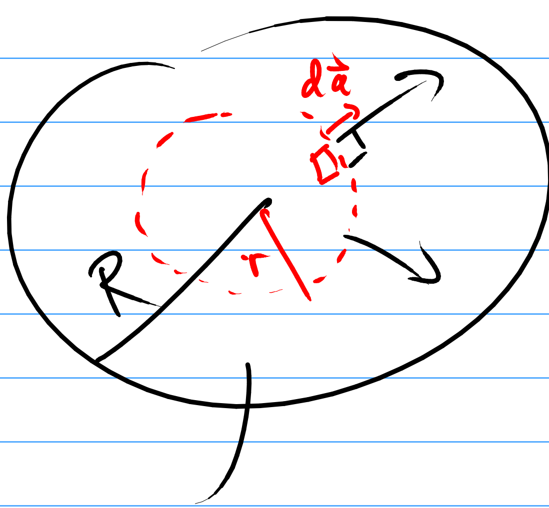
Conductors

$$F = qE = ma$$









$$\oint \vec{E}\cdot d\vec{a} = \oint |\vec{E}||d\vec{a}| \underbrace{\cos\phi}_{1}$$

$$E \underbrace{\oint da}_{4\pi r^2} = \frac{Q_{enc}}{\epsilon_0}$$

$\rho = Ar$ $\quad Q_{enc} = \int \rho \, d\tau = \int A r \, 4\pi r^2 \, dr$

$r^2 \sin\theta \, dr \, d\theta \, d\phi$

$d\tau = 4\pi r^2 dr$

$$Q_{encl} = \int_0^r \underbrace{Ar}_{=\rho} \underbrace{4\pi r^2 dr}_{d\tau} = A 4\pi \frac{r^4}{4}$$

or $d\tau = r^2 \sin^2\theta \, d\theta \, d\phi \, dr$

$$Q_{encl} = \int A r \, r^2 \sin\theta \, d\theta \, d\phi \, dr$$

$$= \int A r^3 dr \underbrace{\int_0^{2\pi}\int_0^{\pi} \sin\theta \, d\theta \, d\phi}_{4\pi}$$

Gauss's Law then becomes

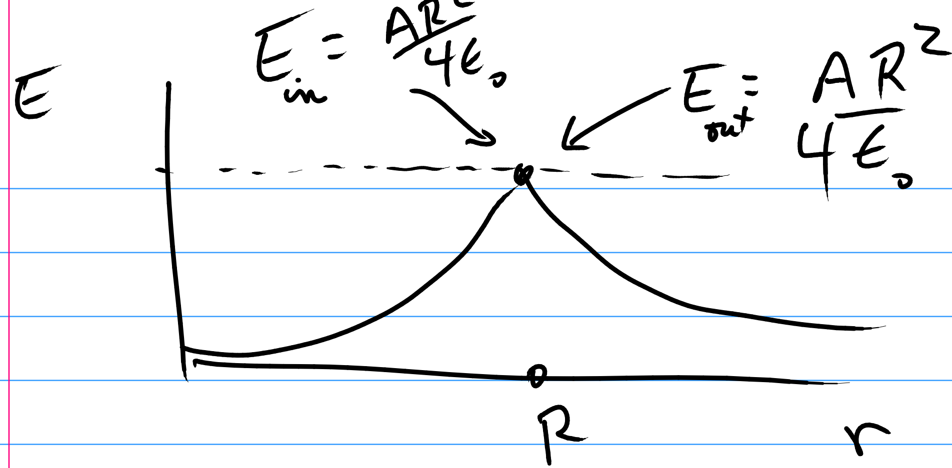
$$E \, 4\pi r^2 = \frac{Q_{encl}}{\epsilon_0} = A \frac{4\pi r^4}{4 \epsilon_0}$$

$$E = A \frac{r^2}{4\epsilon_0} \quad \text{for } r < R$$

for $r > R$ $\quad Q_{encl} = A \frac{4\pi R^4}{4}$

Gauss's law $\quad E \, 4\pi r^2 = A \frac{4\pi R^4}{\epsilon_0 4}$

$$E = A \frac{R^4}{\epsilon_0 4 r^2} \quad r > R$$



E
$E_{in} = \frac{AR^2}{4\epsilon_0}$
$E_{out} = \frac{AR^2}{4\epsilon_0}$
R
r