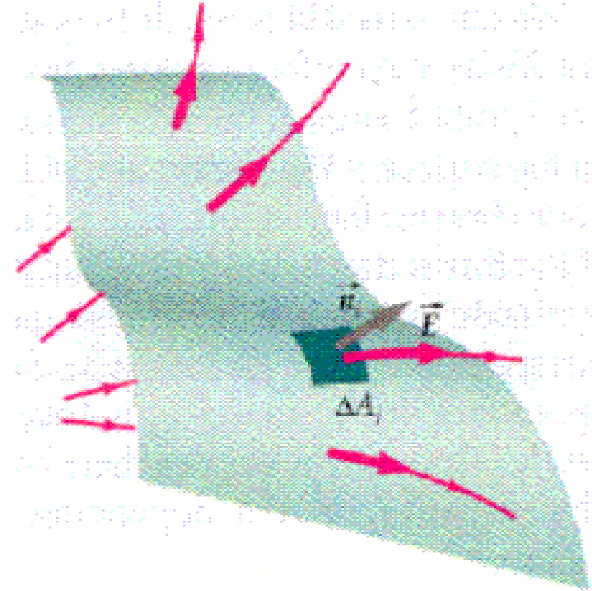
Physics 114 - January 28, 2010

Workshops going okay?

Last Time:

Important

Electric Flux $= \Phi = \int_{\text{Surface}} \vec{E}\cdot d\vec{A}$



Gauss' law

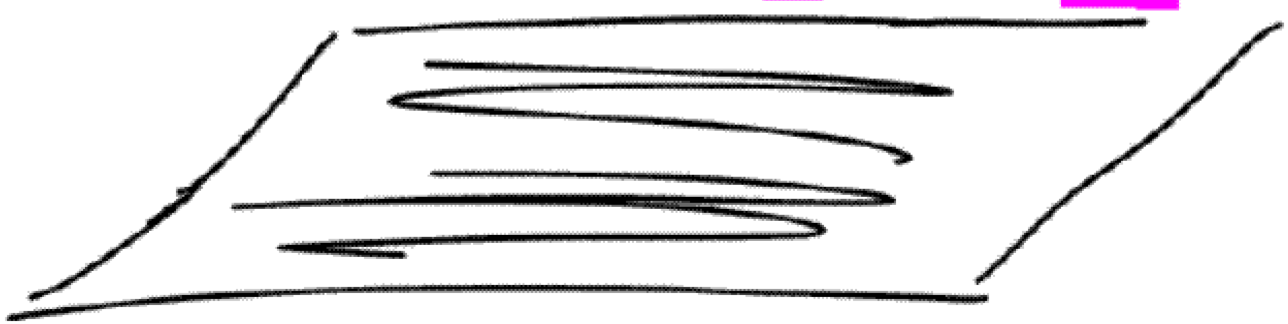
$$\underbrace{\oint}_{\int_{\text{surf}}} \underbrace{\vec{E}\cdot d\vec{A}}_{\vec{E}\cdot\hat{n}\,dA} = \frac{Q_{\text{enclosed}}}{\epsilon_0}$$

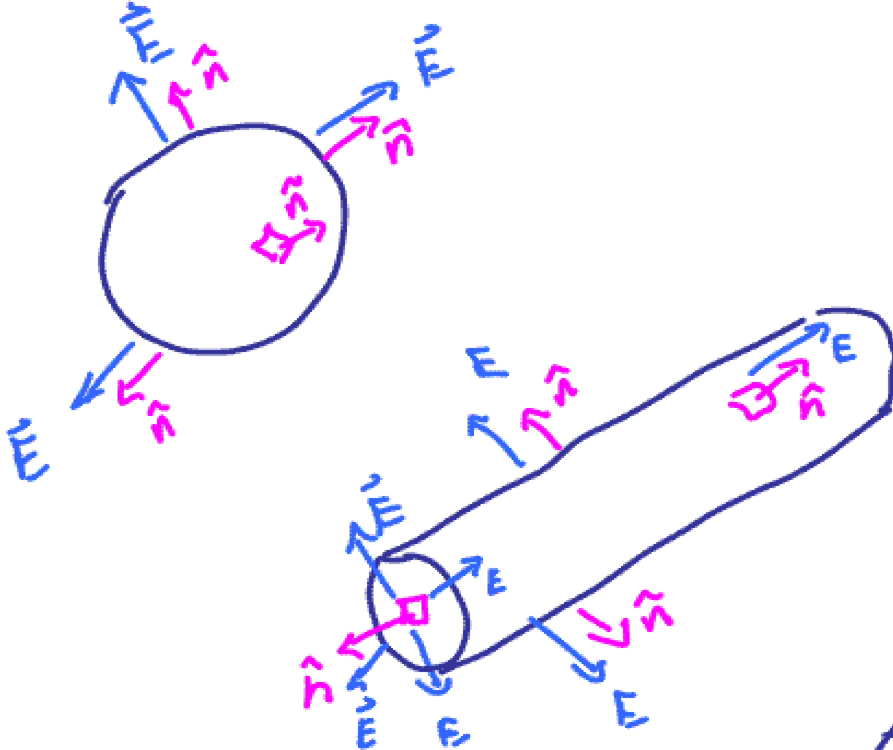
Gauss' Law is useful under certain situations of symmetry

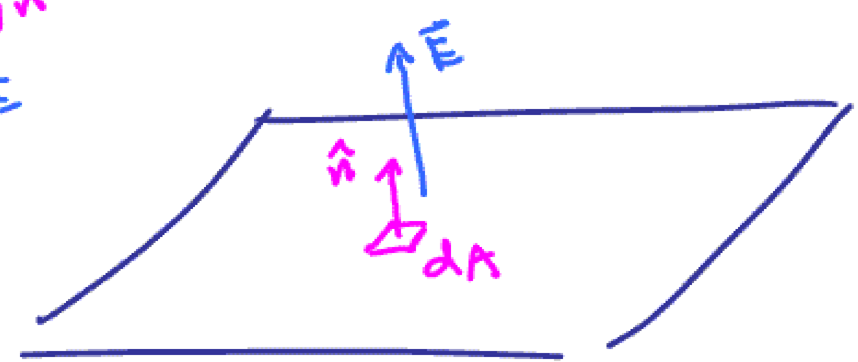
Spherical Symmetry

cylindrical symmetry

planar Symmetry







$$\oint \vec{E}\cdot\hat{n}\,dA = \frac{Q_{encl}}{\epsilon_0}$$

Gauss' law easy to evaluate for $|\vec{E}|$ when
$\vec{E}\cdot\hat{n} = |\vec{E}|$ and $\vec{E}$ constant or 0 on surface

Gauss' Law

$$\oint \vec{E}\cdot d\vec{a} = \frac{Q_{encl}}{\epsilon_0}$$

True in general

integral over volume inside gaussian surface (NOT necessarily all Charge)

$$\oint \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

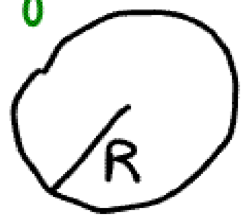
$\int_V \rho \, dv$

Easy if $|\vec{E}|$ is CONSTANT on surface - can pull out of integral

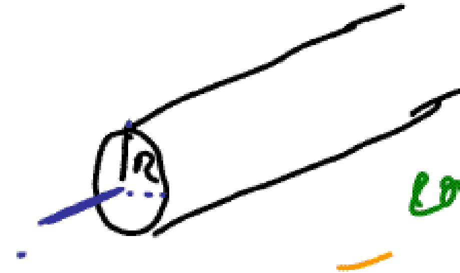
Easy if $\vec{E} \perp d\vec{A}$ or $\vec{E} \parallel d\vec{A}$

integral over Gaussian surface

consider spherical chg dist



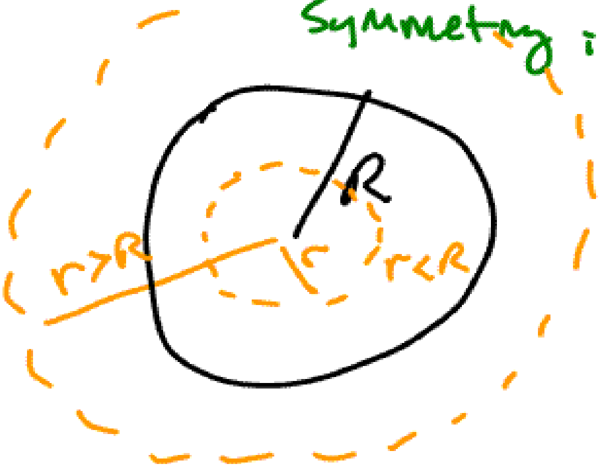
$\rho(r)$



$\rho(r)$

consider cylindrical charge distribution

choose gaussian surfaces with appropriate symmetry in Different "regions"



Evaluate left hand side of Gauss' law

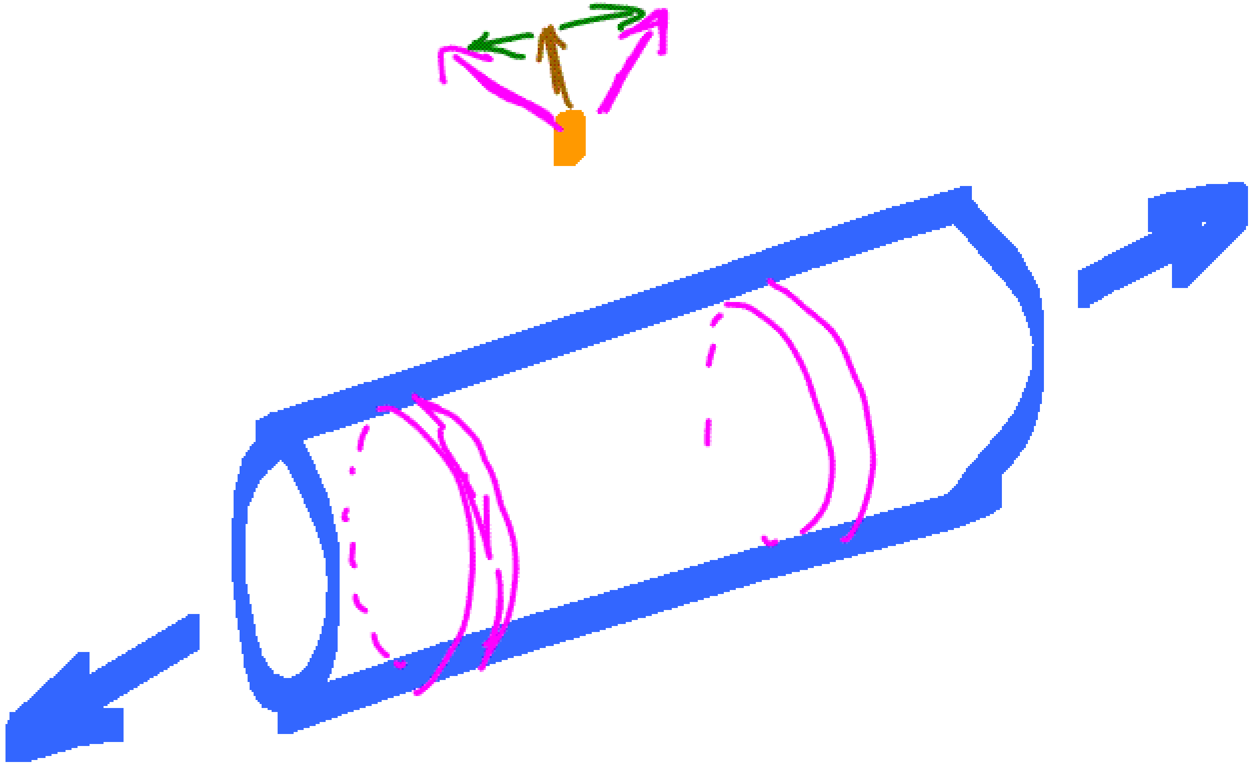
$$\oint \vec{E} \cdot d\vec{A}$$

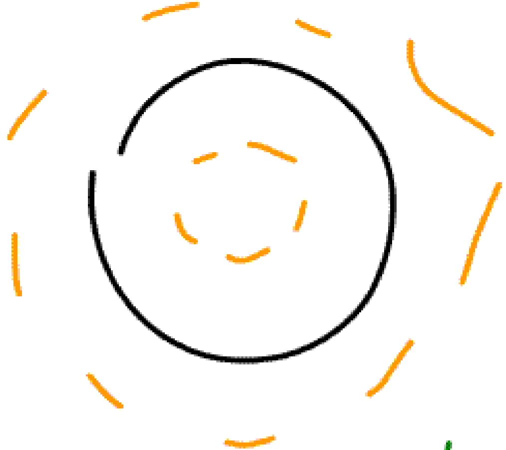
$$\oint |\vec{E}|\, dA$$

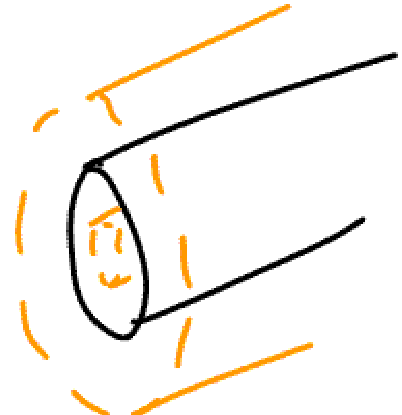
$$|E| \oint dA = |E|\, 4\pi r^2$$

$$\oint \vec{E} \cdot d\vec{A} = \int_{\text{cylinder}} |E|\, dA$$

$$|E|\, 2\pi r L$$







Evaluate Right hand side of Gauss' law

$$\frac{Q_{encl}}{\epsilon_0} = \frac{\int_{volume} \rho(r)\, dv}{\epsilon_0}$$

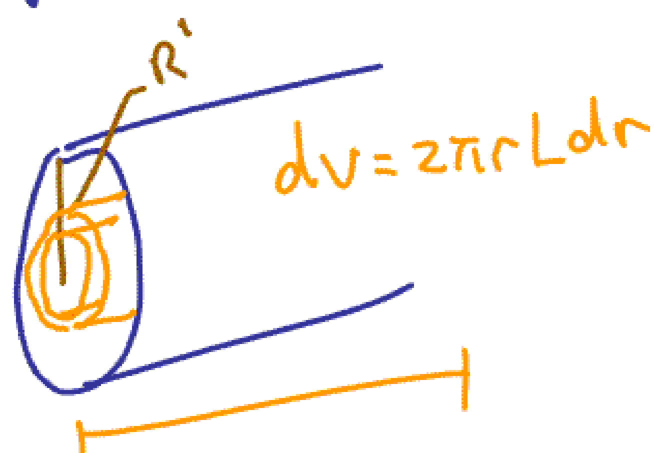
ρ CONSTANT

$$\int \rho\, dv = \rho \int dv$$

what vol sphere? R'

ρ const

$$\int_v \rho\, dv = \rho \int_v dv$$



$$\rho \int dv = \rho \int_0^{R'} 4\pi r^2 dr = \rho \frac{4}{3}\pi R'^3$$

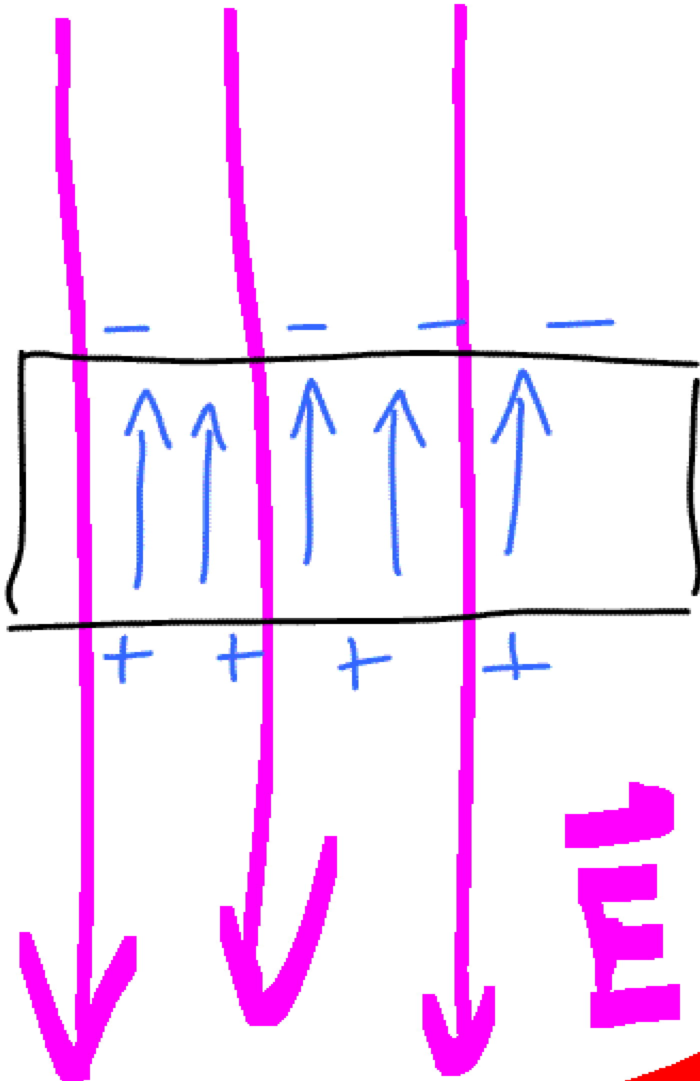
$$\rho \int dv$$

$$\rho \int 2\pi L r dr$$

$$\rho = cr$$

$$\int \rho dv = \int cr\, 4\pi r^2 dr$$

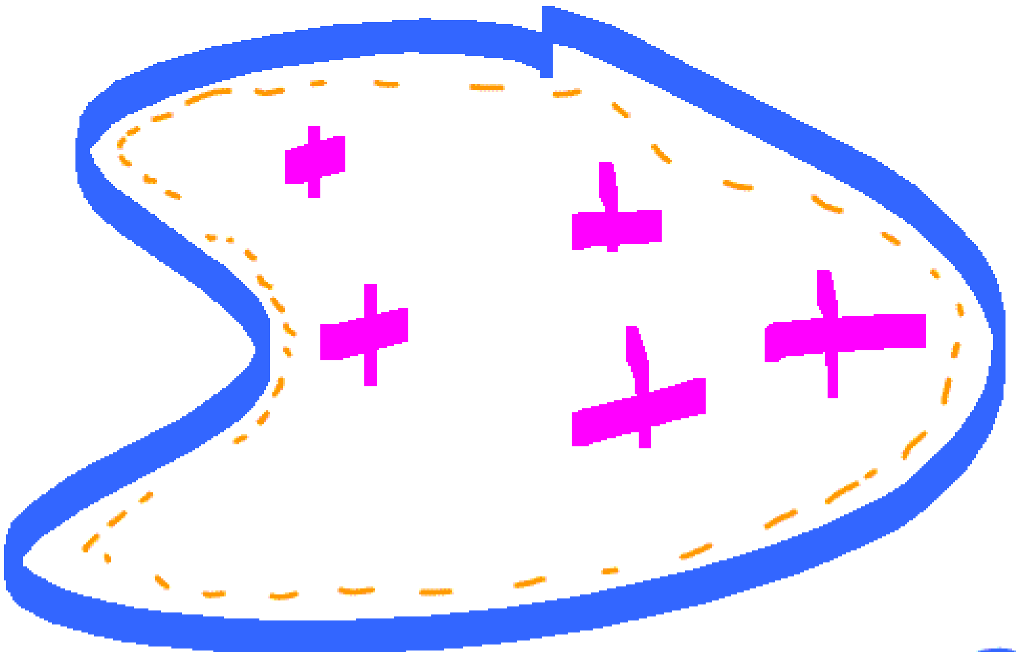
$$4\pi c \int_0^{R} r^3 dr = 4\pi c \frac{R'^4}{4}$$



conductor

$\equiv$ charge will flow freely

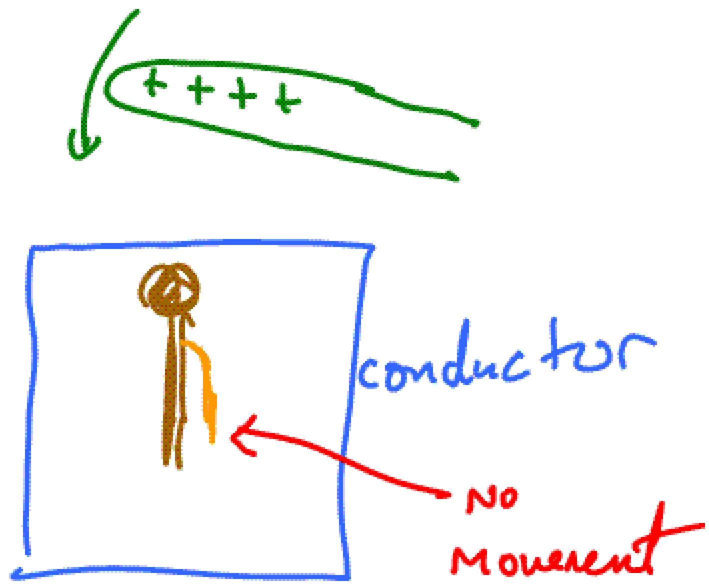
$\vec{E} = 0$ inside conductor (in electrostatics)



$$\oint \underbrace{\cancel{E}}_{0} \cdot dA = \frac{\overbrace{Q_{enc}}^{0}}{\epsilon_0}$$

Charge on a conductor resides on the surface of the conductor

Electrostatic Shielding



$\vec{E}$ inside a conductor is zero