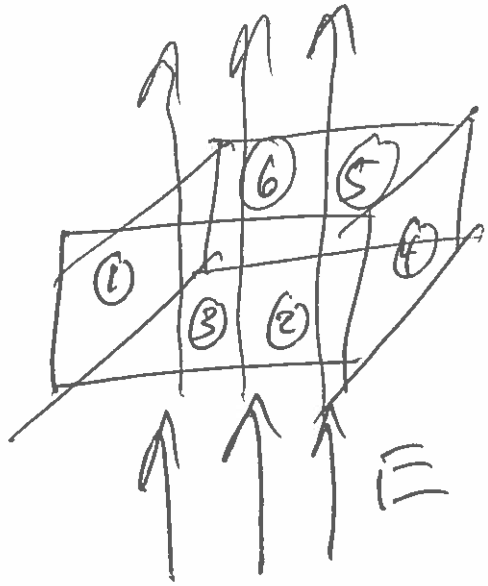
$$\Phi = \vec{E} \cdot \vec{A}$$



① - Left side
② - bottom
③ - Front
④ Right
⑤ back
⑥ Top

$$\Phi_{Net} = ? = 1$$

$$\Phi_{Net} = \Phi_{left} + \Phi_{Right} + \Phi_{Front} + \Phi_{Back} + \Phi_{Bot} + \Phi_{Top}$$

$$\Phi_{net} = 0 \cancel{+ E\,A_{Bot} \cos(180)}^{\,0} + 0 + 0 + EA\cos(180) + EA\cos(0)$$

$$\vec{A} \cdot \vec{B} = |\vec{A}||\vec{B}| \cos\theta_{AB}$$

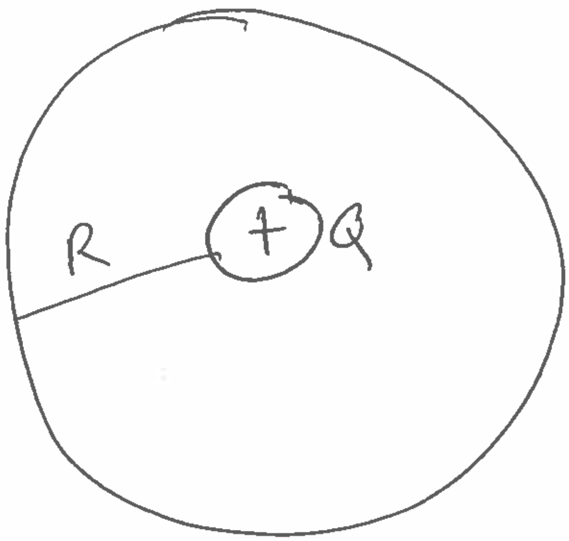
$$\Phi_{net} = EA(-1) + EA(+1) = 0$$

Gauss's Law

$$\Phi_{Net} = \frac{Q_{enc}}{\varepsilon_0} = 0$$

$$Q_{enc} = 0$$

$Q = 1\mu C$



$$\vec{E} = \frac{kQ}{r^2}\hat{r}$$

$$\vec{E}(r=R) = \frac{kQ}{R^2}\hat{r}$$

Volume is a sphere of radius R

Area of sphere $= 4\pi R^2 \hat{r}$

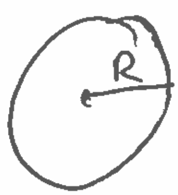
$$\Phi_{net} = \vec{E}\cdot\vec{A} = \frac{kQ}{R^2}\hat{r} \cdot 4\pi R^2 \hat{r}$$

$$\Phi_{net} = \frac{kQ}{R^2}\,4\pi R^2\,\underbrace{\hat{r}\cdot\hat{r}}_{\underbrace{(1)(1)\cos(0)}_{=1}}$$

$$\Phi_{net} = k4\pi Q$$

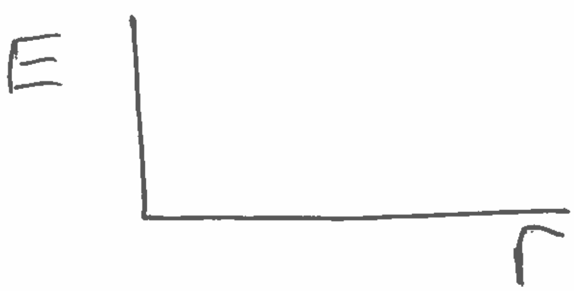
$$= \left(\frac{1}{4\pi\varepsilon_0}\right)4\pi Q$$

$$\Phi_{net} = \frac{Q}{\varepsilon_0} = \frac{Q_{enc}}{\varepsilon_0}$$



← Ball of charge uniformly distributed

we want.



To use Gauss's Law

we need a surface that $\vec{E}$ is constant on.

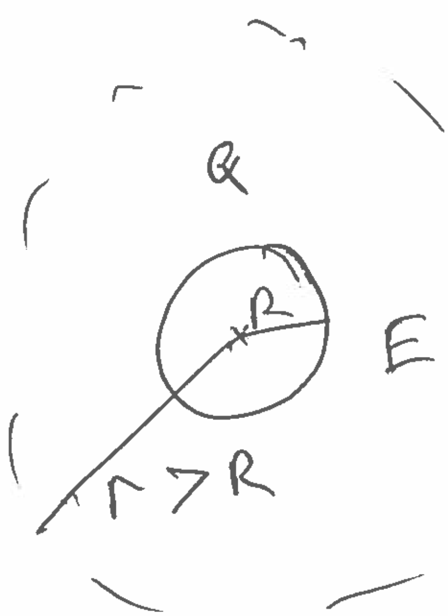
for a spherical charge distribution

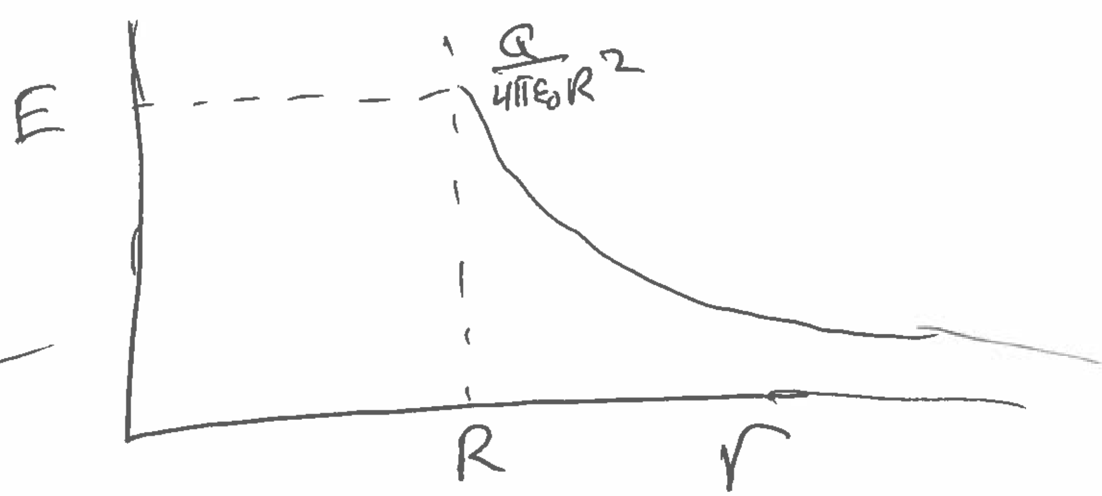
E is constant on a sphere

$$E \cdot A = \frac{Q_{enc}}{\varepsilon_0}$$

$$E\, 4\pi r^2 = \frac{Q_{enc}}{\varepsilon_0}$$

$$E = \frac{Q_{enc}}{4\pi \varepsilon_0 r^2}$$





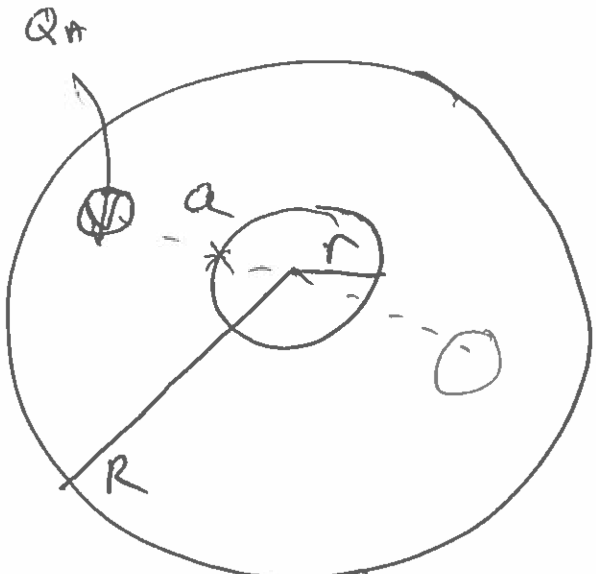
for

$r \geq R \qquad E = \frac{kQ}{r^2} \qquad k = \frac{1}{4\pi\epsilon_0}$

at $r = R \qquad E = \frac{kQ}{R^2} = \frac{Q}{4\pi\epsilon_0 R^2}$

$Vol_{enc} = \frac{4\pi}{3} r^3$

$Q_{enc} = \rho \, Vol_{enc}$



$\rho = \frac{\text{Charse}}{\text{Volume}}$

$\rho = \frac{Q}{\frac{4\pi}{3} R^3}$

$Q_{enc} = \frac{Q}{\frac{4}{3}\pi R^3} \frac{4}{3}\pi r^3$

$\boxed{Q_{enc} = \frac{Q r^3}{R^3}}$

$$Q_{enc} = \frac{Q r^3}{R^3}$$

at $r = R$ $\quad Q_{enc} = \frac{Q R^3}{R^3} = Q$ ✓

$r = 0$ $\quad Q_{enc} = \frac{Q\, 0^3}{R^3} = 0$ ✓

$$E = \frac{k Q_{enc}}{r^2} = \frac{\frac{k Q r^3}{R^3}}{r^2}$$

for $r < R$ $\quad \boxed{E = \frac{kQ}{R^3} r}$