Midterm End of Next Week!

PY 202 5

reading: 23.1-2

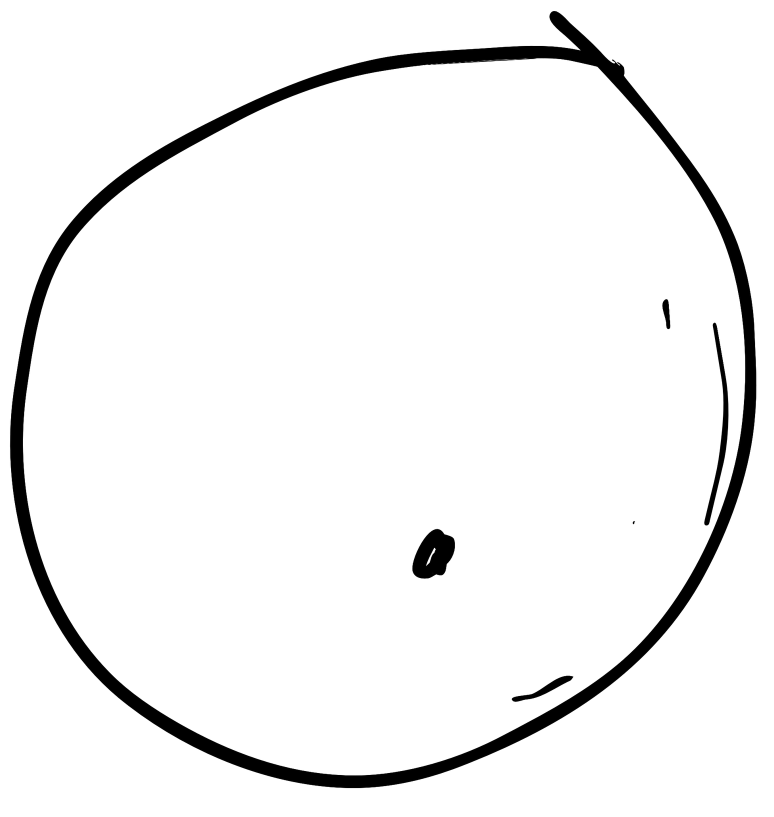
exam

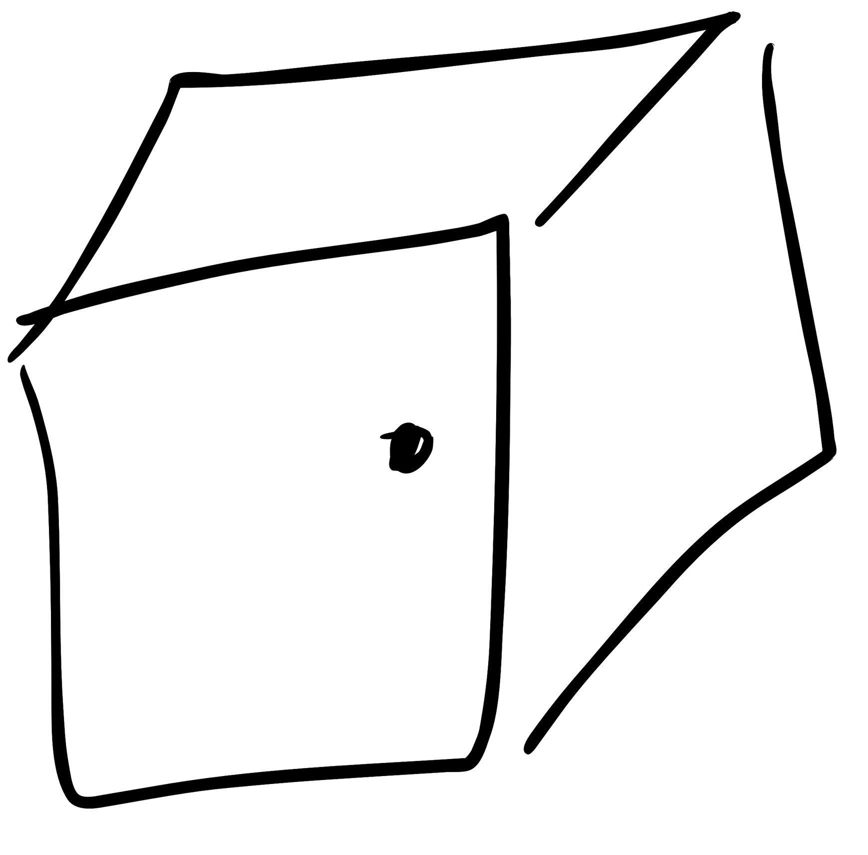
- all HW is fair game
- other stuff specified

Quiz 2

- You missed $\cos(30^\circ)$ . . . :/

1)





Gauss's Law:

$$\underbrace{\oint \vec{E} \cdot \hat{n}\, dA}_{\phi \text{ (flux)}} = \frac{Q_{enc}}{\varepsilon_0}$$

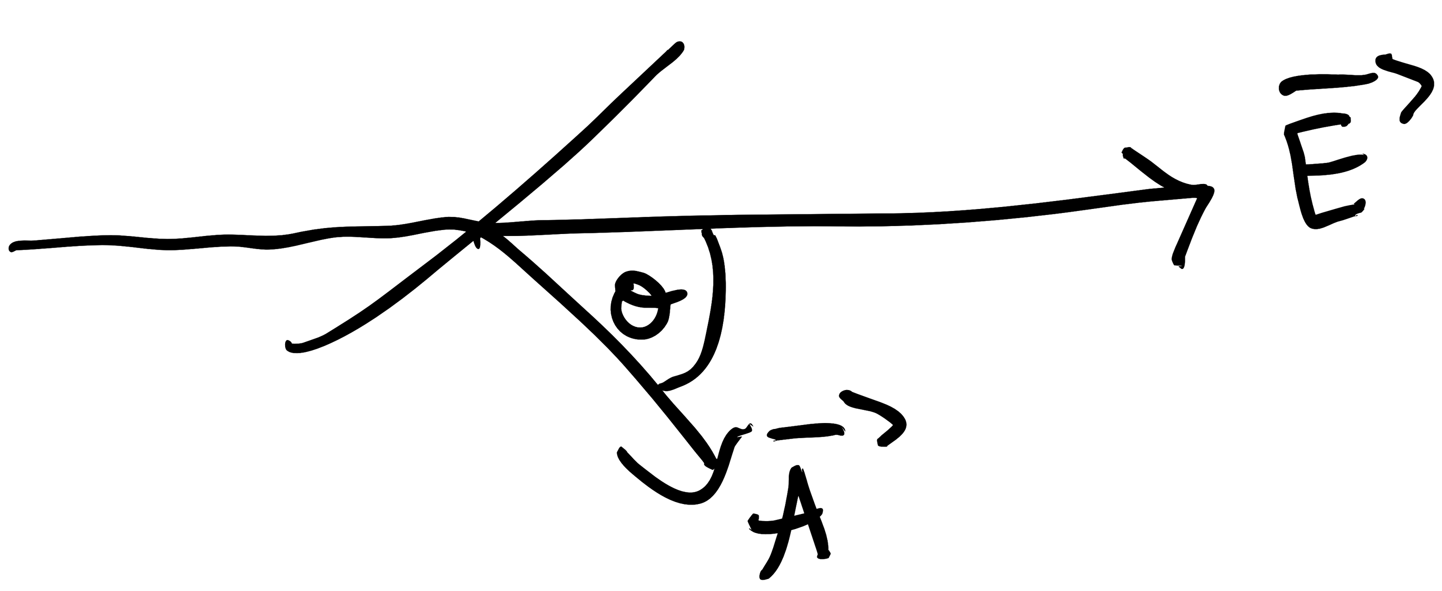
$$\phi = \frac{Q_{enc}}{\varepsilon_0}$$

$$= \frac{q}{\varepsilon_0} \text{ for each}$$

Thus, they're equal.

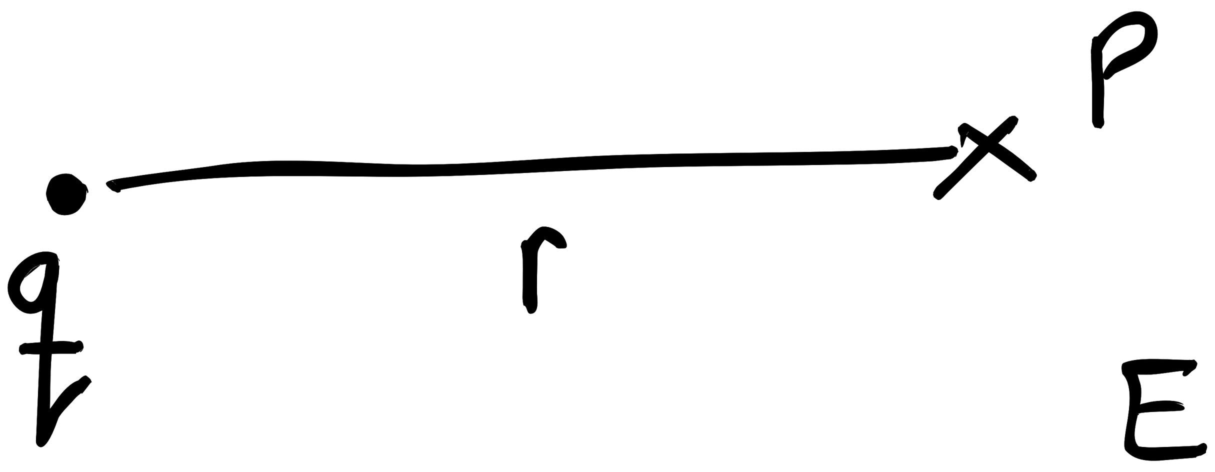
2) remember $\hat{n} \perp \hat{A}$!!

$$\phi = \int \vec{E} \cdot \hat{n}\, dA = E A \cos(30°)$$



22 Gauss's Law

Muy fuerte



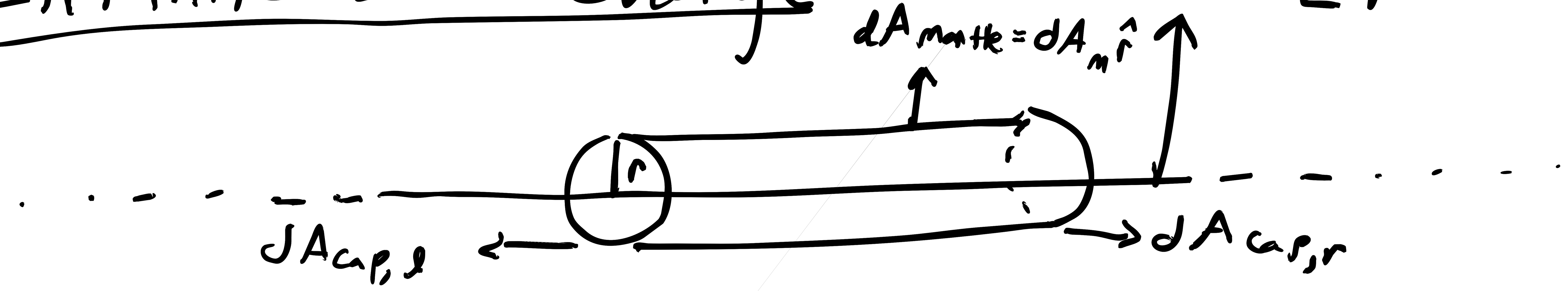
E @ P = ?

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

$$\oint \vec{E} \cdot \hat{n} \, dA = \frac{Q_{enc}}{\varepsilon_0} \Rightarrow \text{solve for } E$$

Infinite Line charge

$\vec{E} = E\hat{r}$



E at distance r from line charge

$$\oint_{cyl} \vec{E} \cdot \hat{n} \, dA = \int_{mantle} E\hat{r} \cdot \hat{r} \, dA_{mantle} = E \int_{M} dA_m = E 2\pi RL$$

$$\frac{Q_{encl}}{\varepsilon_0} = \frac{\lambda L}{\varepsilon_0}$$

Solve for E:

$$\boxed{\begin{aligned} E &= \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r} \\ \vec{E} &= \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}\hat{r} \end{aligned}}$$

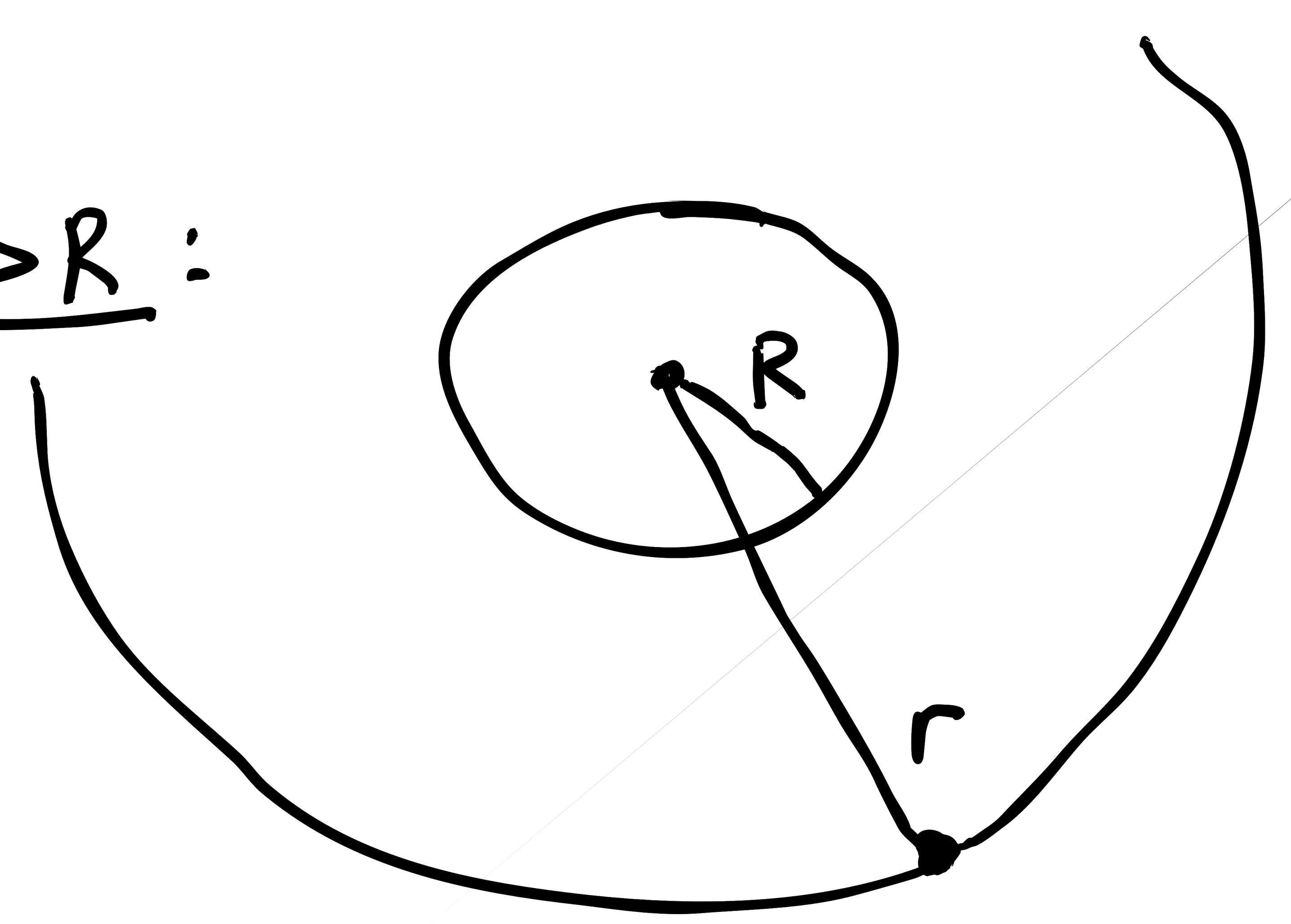
That wasn't so bad!

<u>ex1</u> Solid sphere of radius r uniformly charged $\rho = \frac{Q}{V}$

E-field at distance r from center of sphere

for $r > R$ and $r \leq R$

<u>$r>R$</u>:



Gaussian Surface

$\vec{E} = E\,\hat{r}$ (radial from sphere)

$d\vec{A}_{Gauss} = dA\,\hat{r}$ (i.e. $\hat{r} = \hat{n}$

$$\oint \vec{E} \cdot \hat{n}\, dA = \oint_{sphere} E\hat{r} \cdot \hat{r}\, dA = E \oint dA$$

$$= E\, 4\pi r^2$$

$$\frac{Q_{enc}}{\varepsilon_0} = \frac{Q}{\varepsilon_0} = \rho \frac{\left(\frac{4}{3}\pi R^3\right)}{\varepsilon_0}$$

for $r > R$, $\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2}\, \hat{r}$

<u>For $r < R$</u>: Φ same, Q_{enc} different

$$\frac{Q_{enc}}{V_{enc}} = \frac{Q_{tot}}{V_{tot}}$$

$$Q_{enc} = \frac{Q}{V} V_{enc} = Q\left(\frac{V_{enc}}{V_{tot}}\right)$$

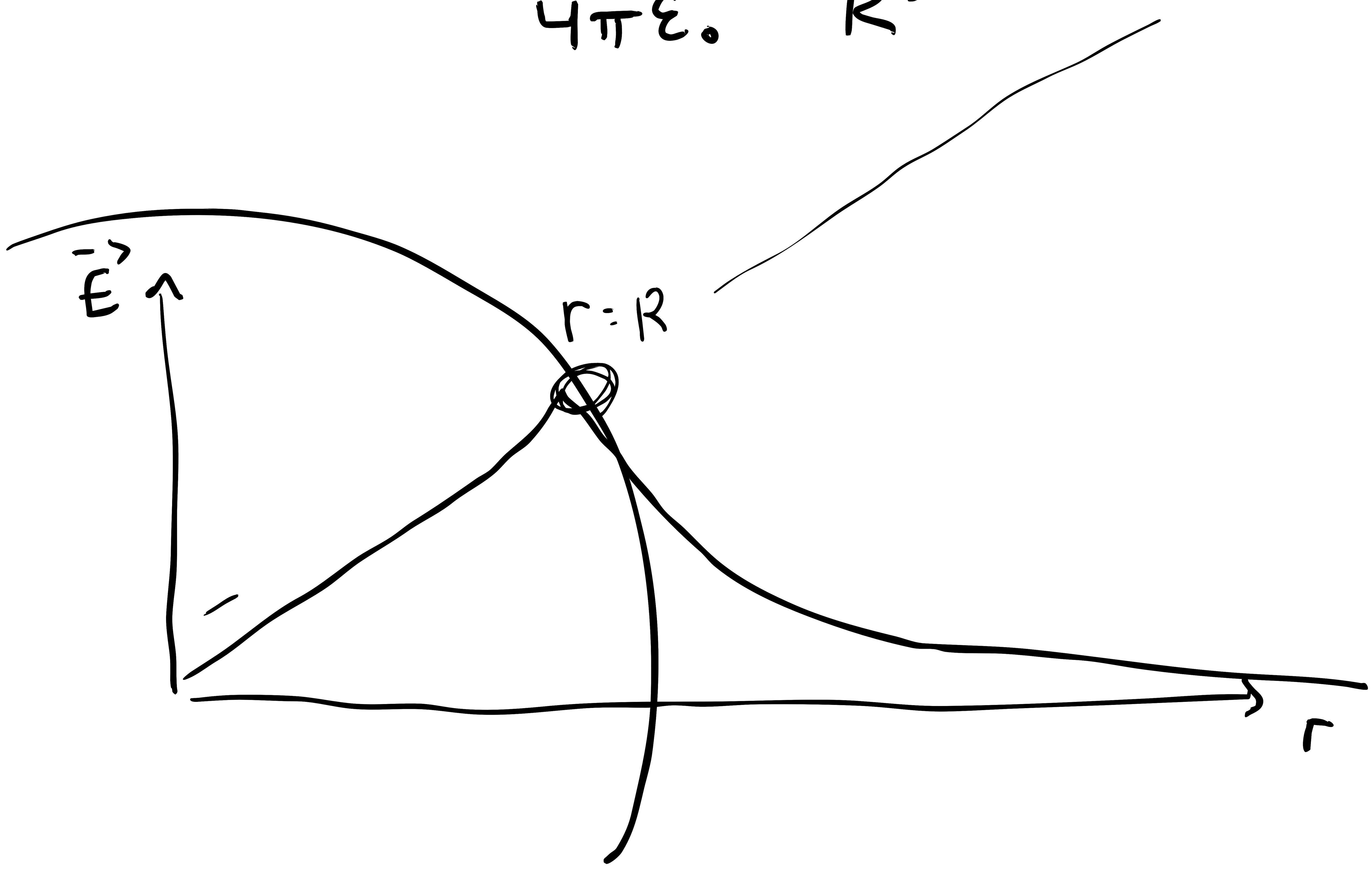
$$\frac{Q_{enc}}{\varepsilon_0} = \frac{\rho\left(\frac{4\pi}{3}\right)R^3}{\frac{4\pi}{3}\,R^3} = \frac{\frac{4\pi}{3}\,r^3}{\varepsilon_0}$$

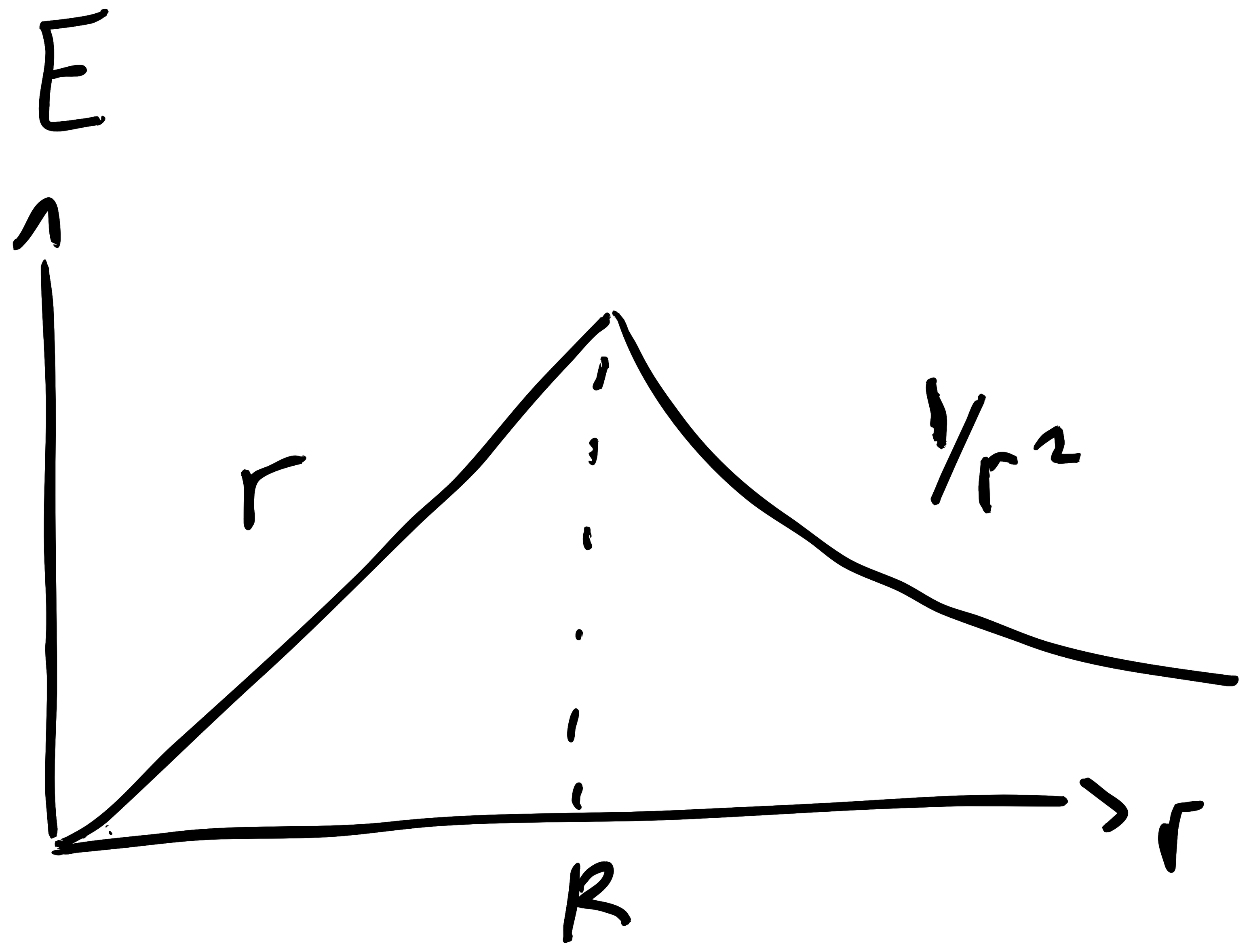
$$E = \frac{1}{\cancel{4}\pi\varepsilon_0}\,\rho\,\frac{\cancel{4}\pi}{3}\,r$$

$$= \frac{\rho r}{3\varepsilon_0} = \frac{\rho}{3\varepsilon_0}\,r$$

$$= \frac{Q}{4\pi\varepsilon_0}\,\frac{r}{R^3}$$

$$\vec{E} = \frac{Q}{4\pi\varepsilon_0}\,\frac{r}{R^3}\,\hat{r}$$



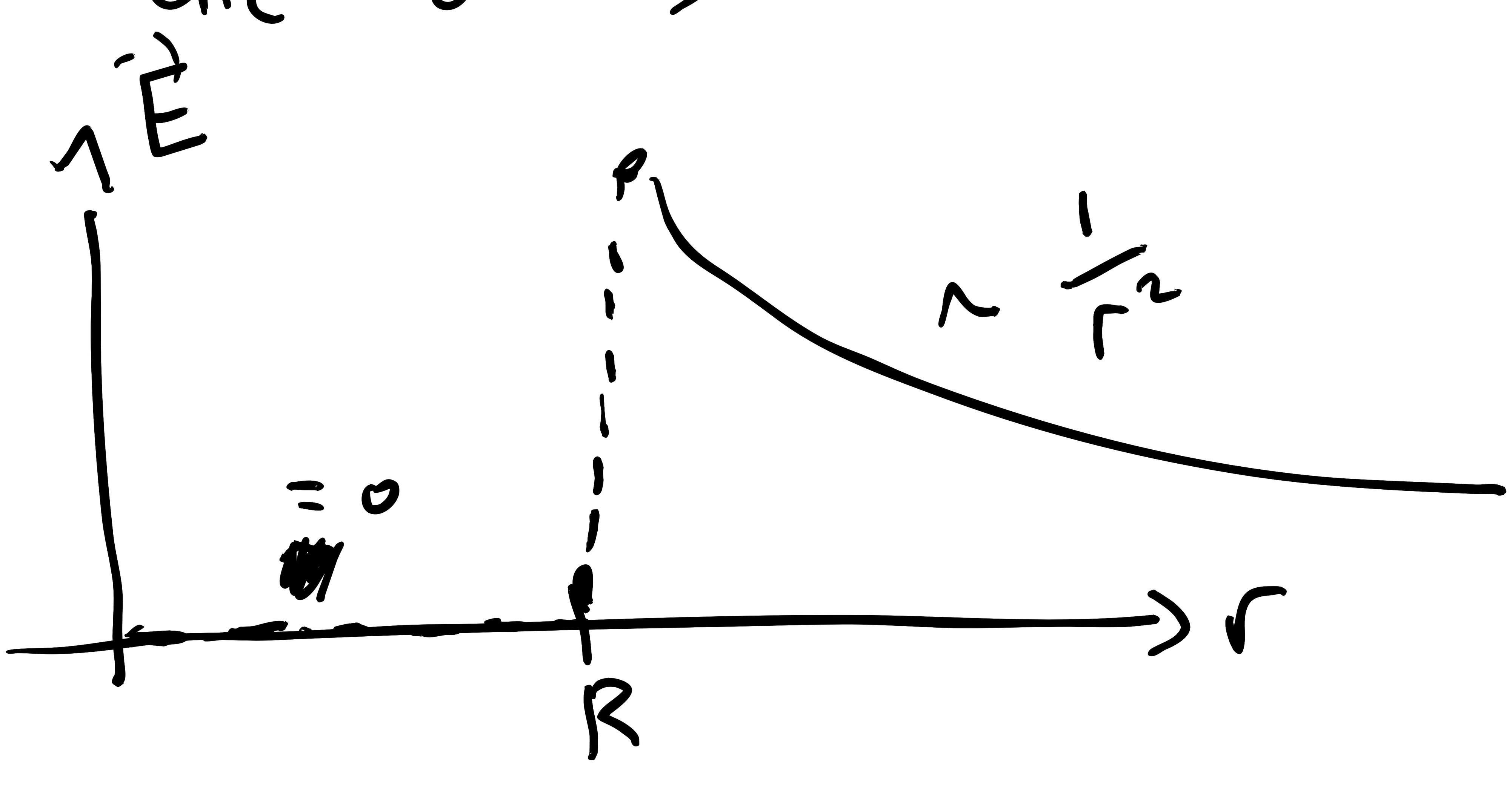


ex) Spherical shell

- uniform surface charge
- total charge Q
- radius R
- $\sigma = \frac{Q}{A}$

$r < R$: $Q_{enc} = 0 \Rightarrow \vec{E} = 0$

$r > R$: pt. q



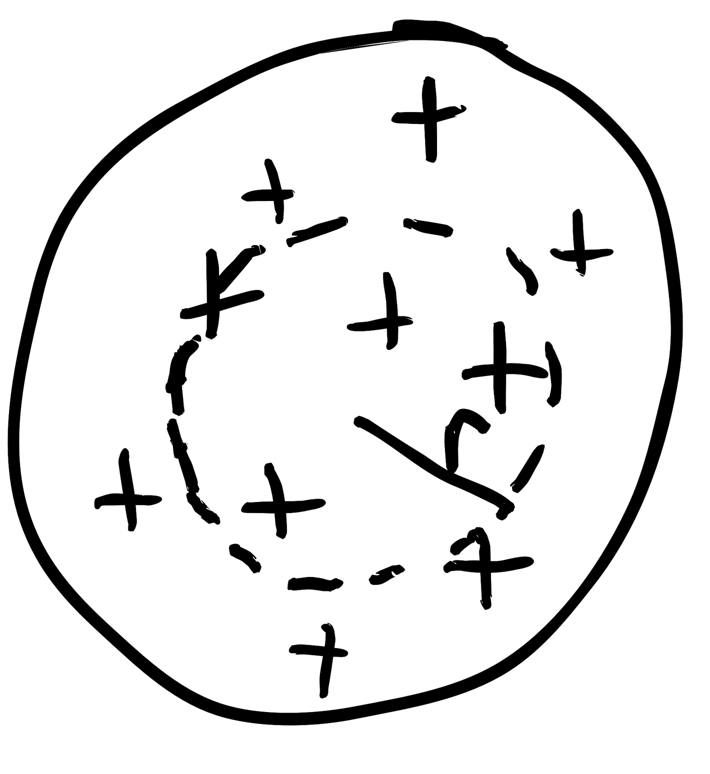
Clicker quiz

inf disk: $\frac{\sigma}{2\varepsilon_0}$

no r-dependence for infinite disks!

ex| book, problem 83

uniformly charged sphere w/ volume charge density ρ



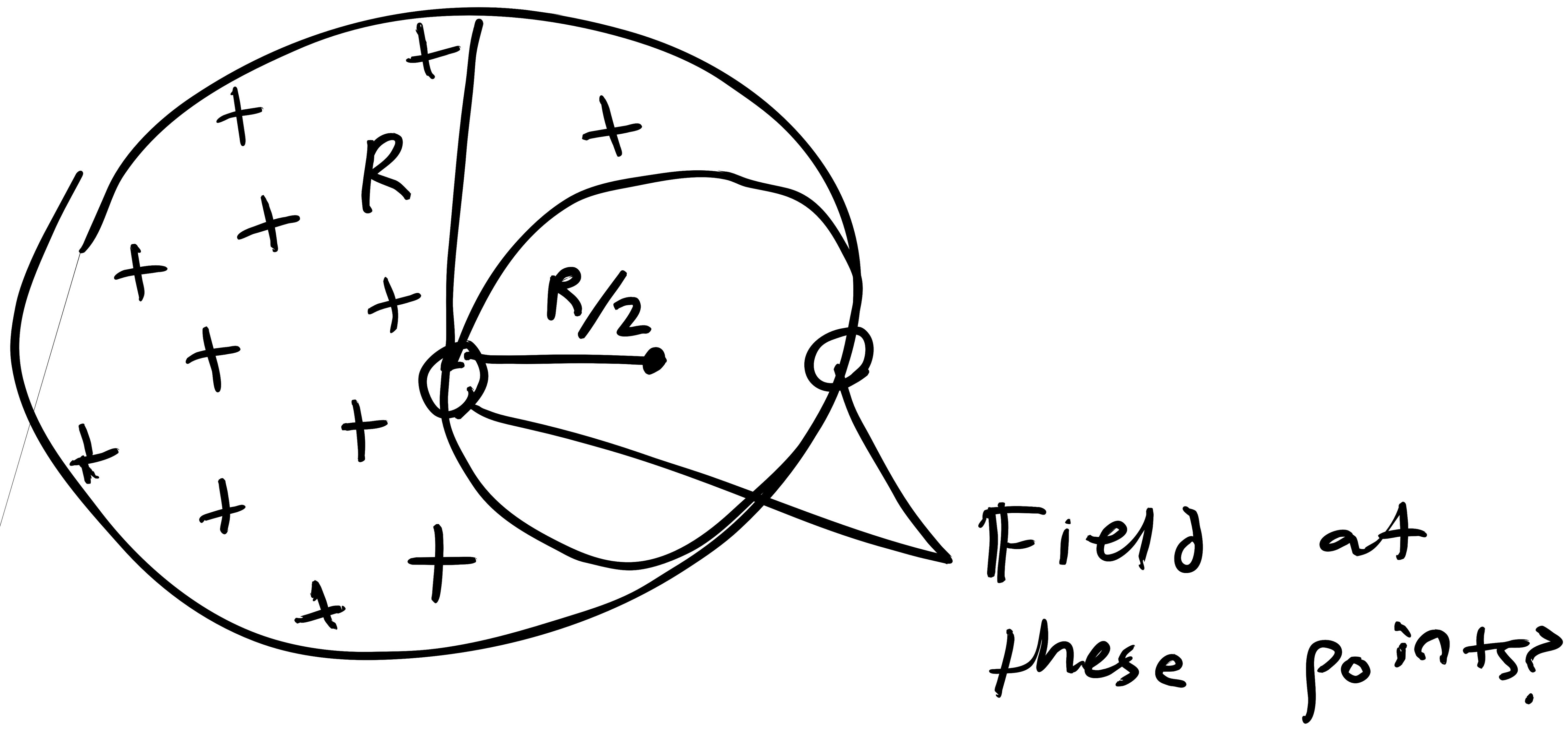
$$\oint \vec{E} \cdot \hat{n} \, dA = \ldots = E 4\pi r^2$$

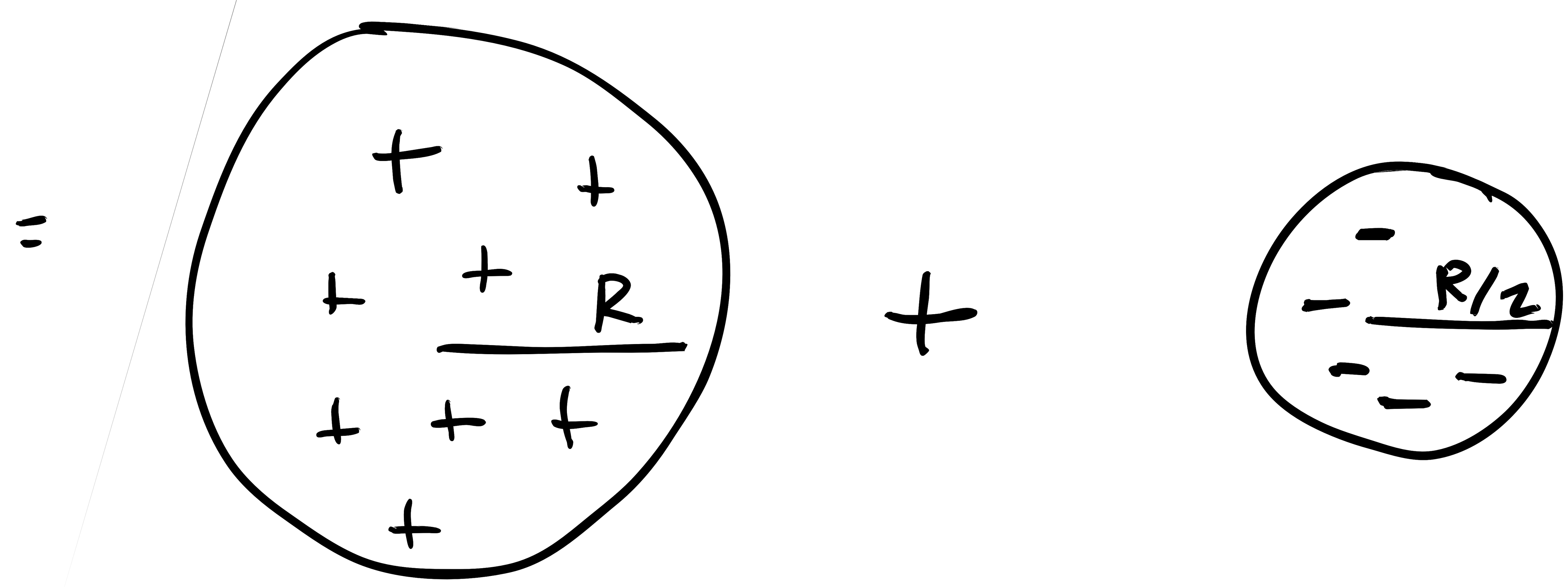
$$\frac{Q_{enc}}{\varepsilon_0} = \frac{\rho}{\varepsilon_0} \frac{4\pi}{3} r^3$$

$$\frac{Q_{enc}}{V_{enc}} = \frac{Q_{tot}}{V_{tot}} = \rho$$

$$\Rightarrow \quad E = \frac{1}{3\,\varepsilon_0}\,\rho\, r$$

Now, cut out a sphere:





$$\vec{E} = \vec{E}_{\rho} + \vec{E}_{\rho^-}$$

$$\oint \vec{E}\cdot\hat{n}\,dA = \oint \vec{E}_{\rho^+}\cdot\hat{n}\,dA + \oint \vec{E}_{\rho^-}\cdot\hat{n}\,dA$$

Check Moodle for rest.