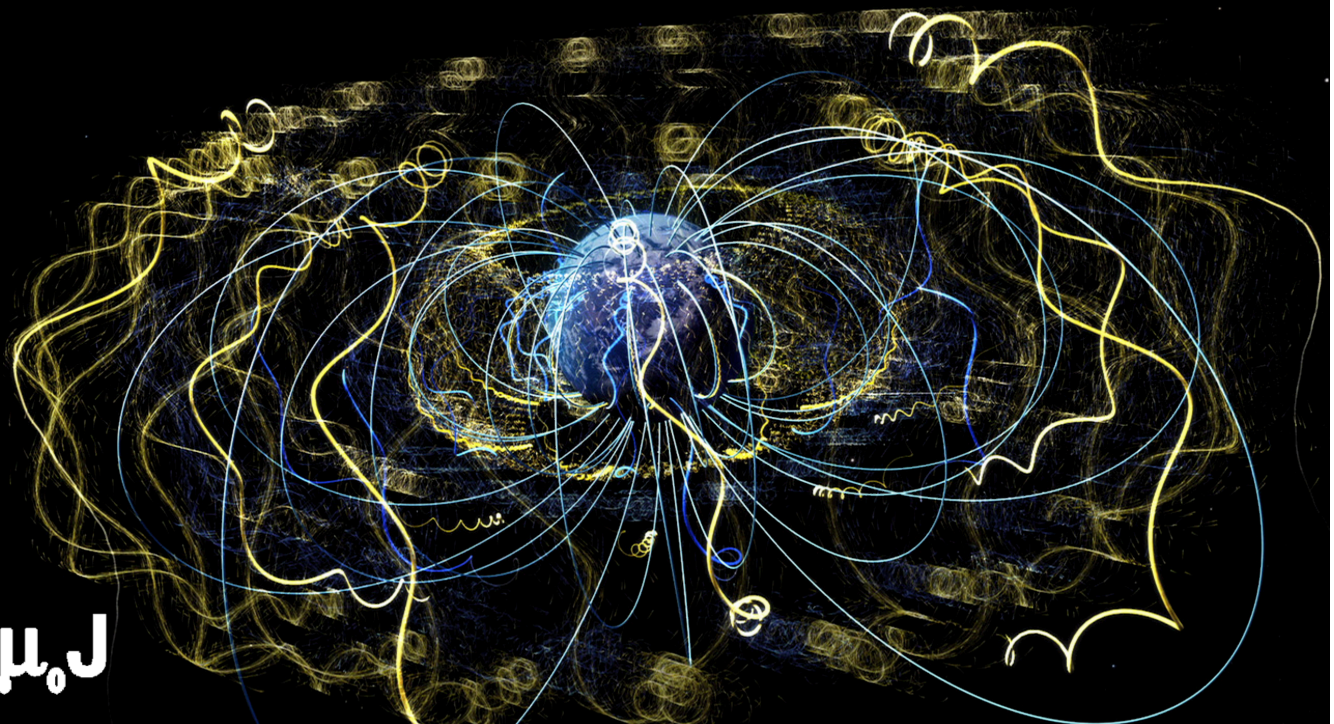
$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{B} = \mu_0 \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t} + \mu_0 \mathbf{J}$$



Electricity and Magnetism I: 3811

Professor Jasper Halekas

Van Allen 301

MWF 9:30-10:20 Lecture

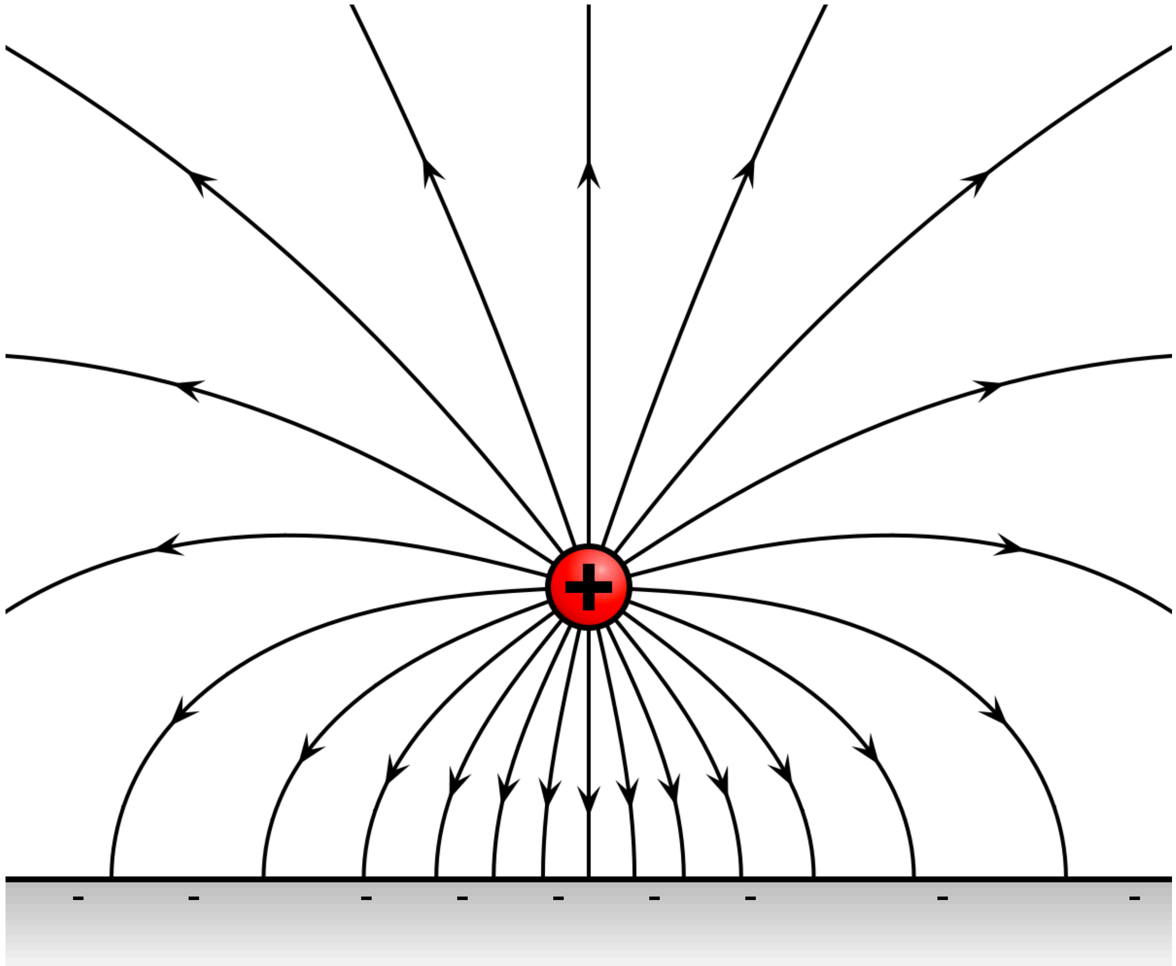
Announcements I

- Final Exam scheduled for 12:30-2:30pm Wednesday 12/18 in Van 301 (this room)

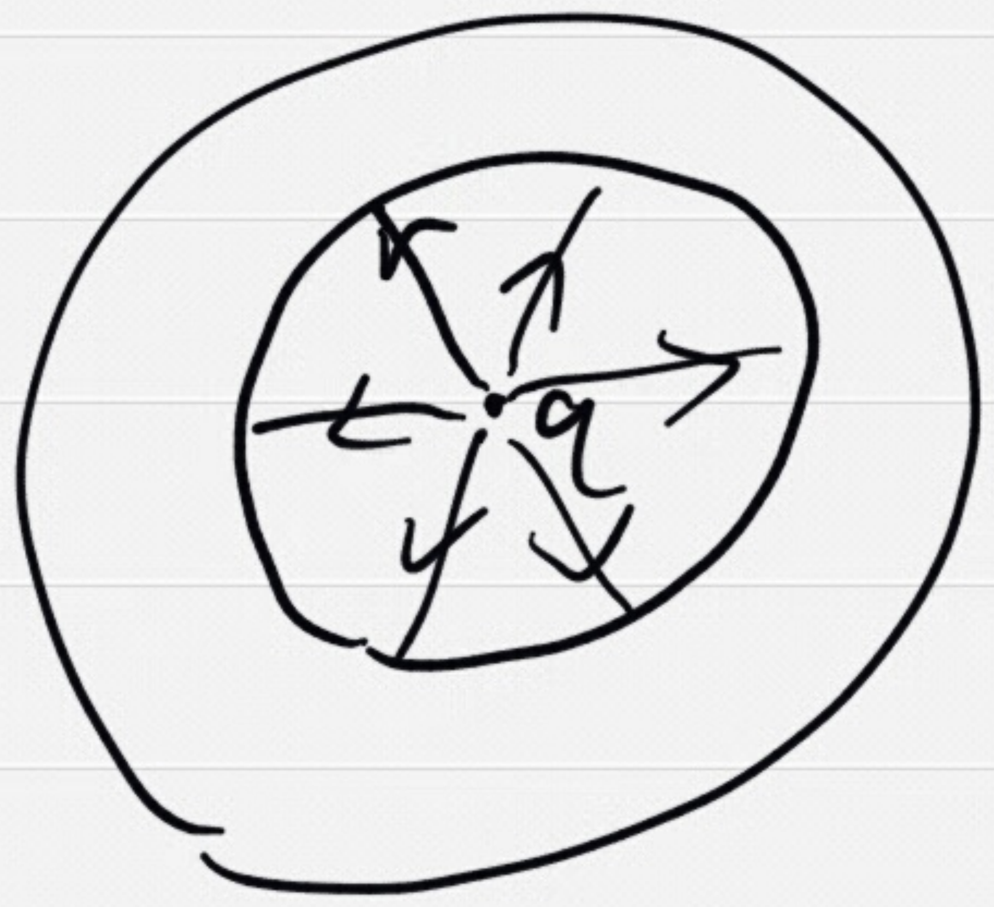
Announcements II

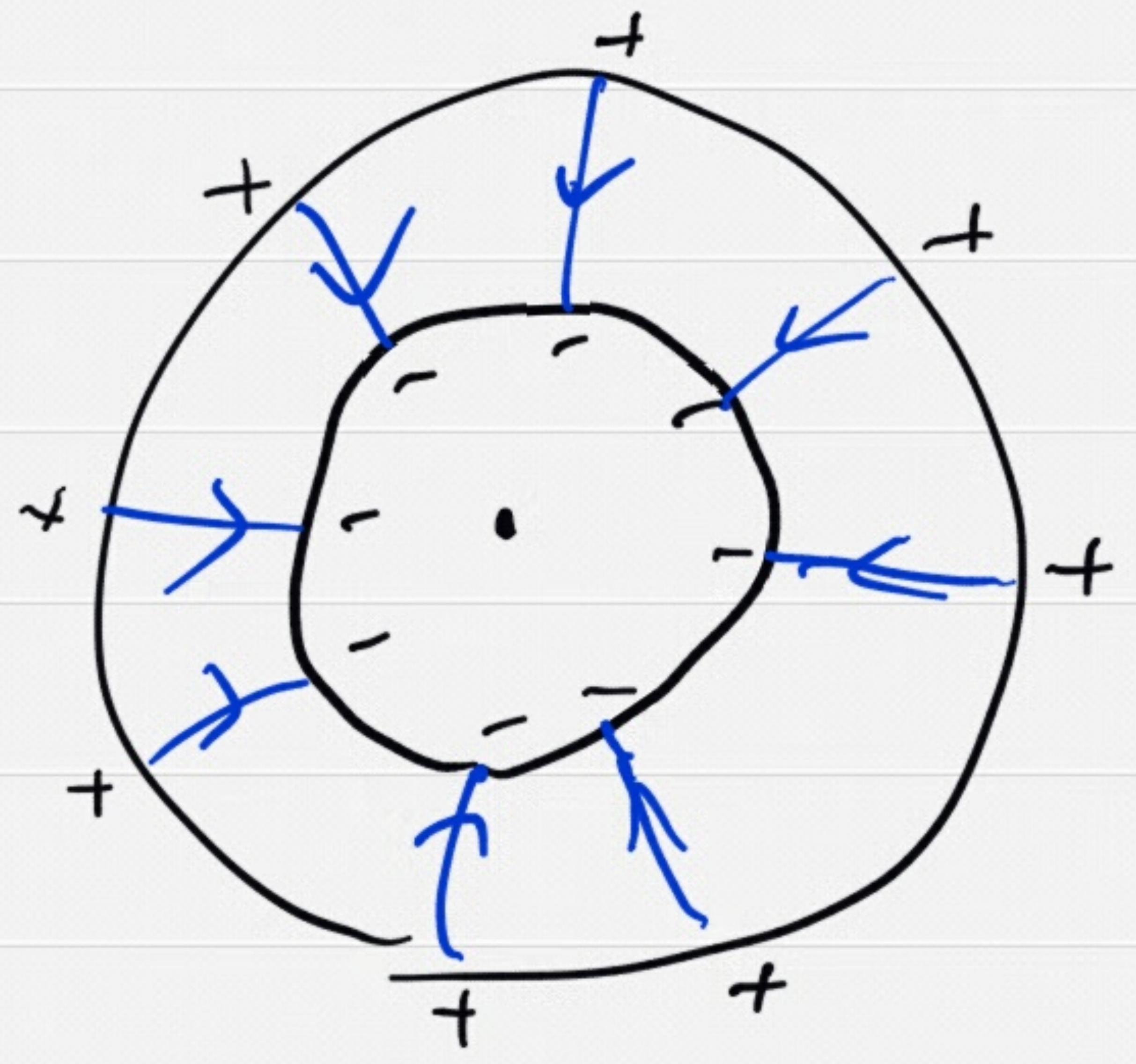
- First midterm exam is next Wednesday (Oct. 2) during normal class hours
  - Exam covers Griffiths Ch. 1-2 & lectures through Friday 9/27
  - Equation sheet posted on course website
    - You are responsible for printing this, annotating it if you desire, and bringing it to the test
  - Two sample midterms posted on course website
    - Format of this year's exam will be very similar
    - Problems will include spherical, cylindrical, and Cartesian geometry

Induced Charge



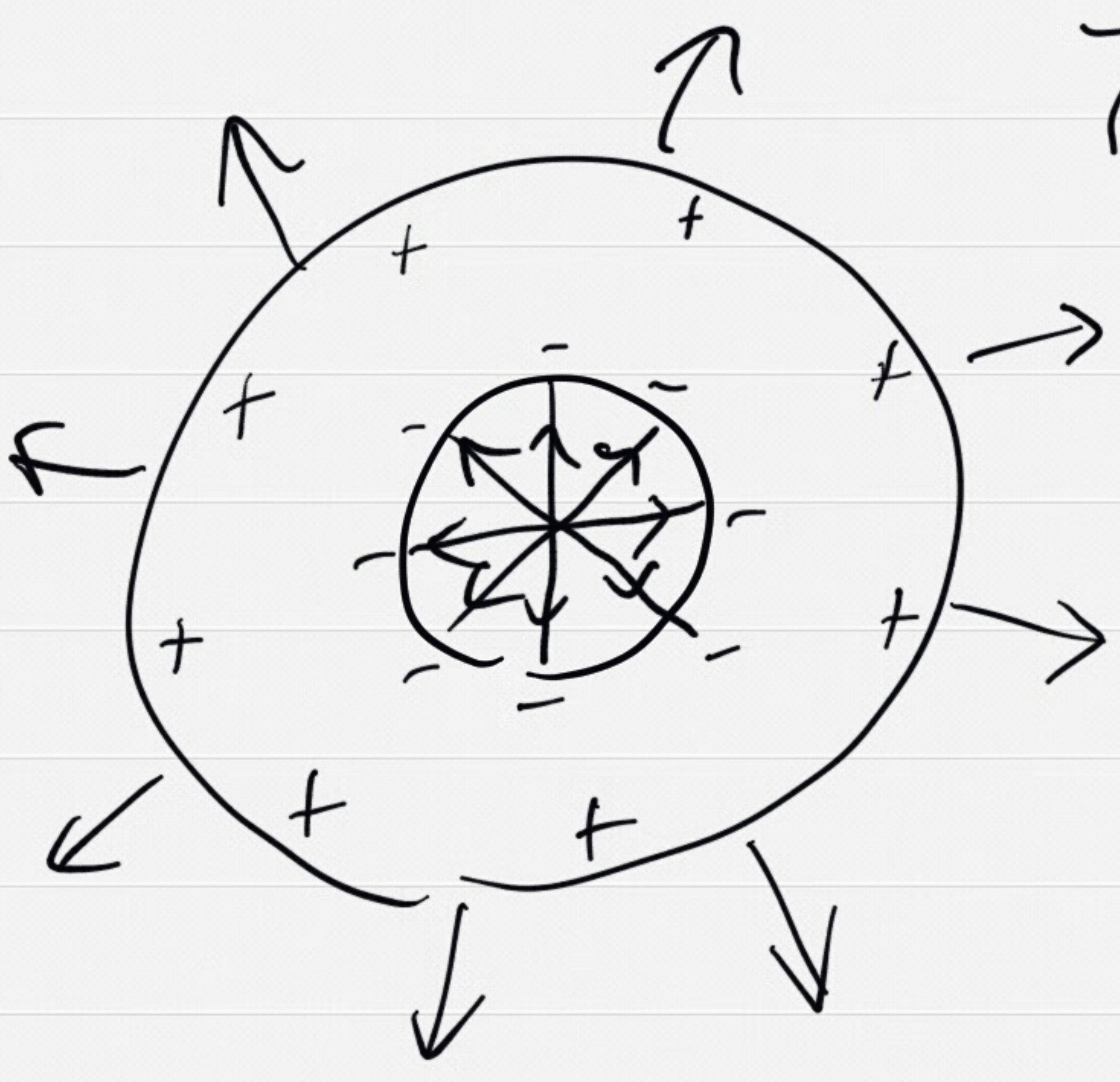
Conductor w/ Cavity



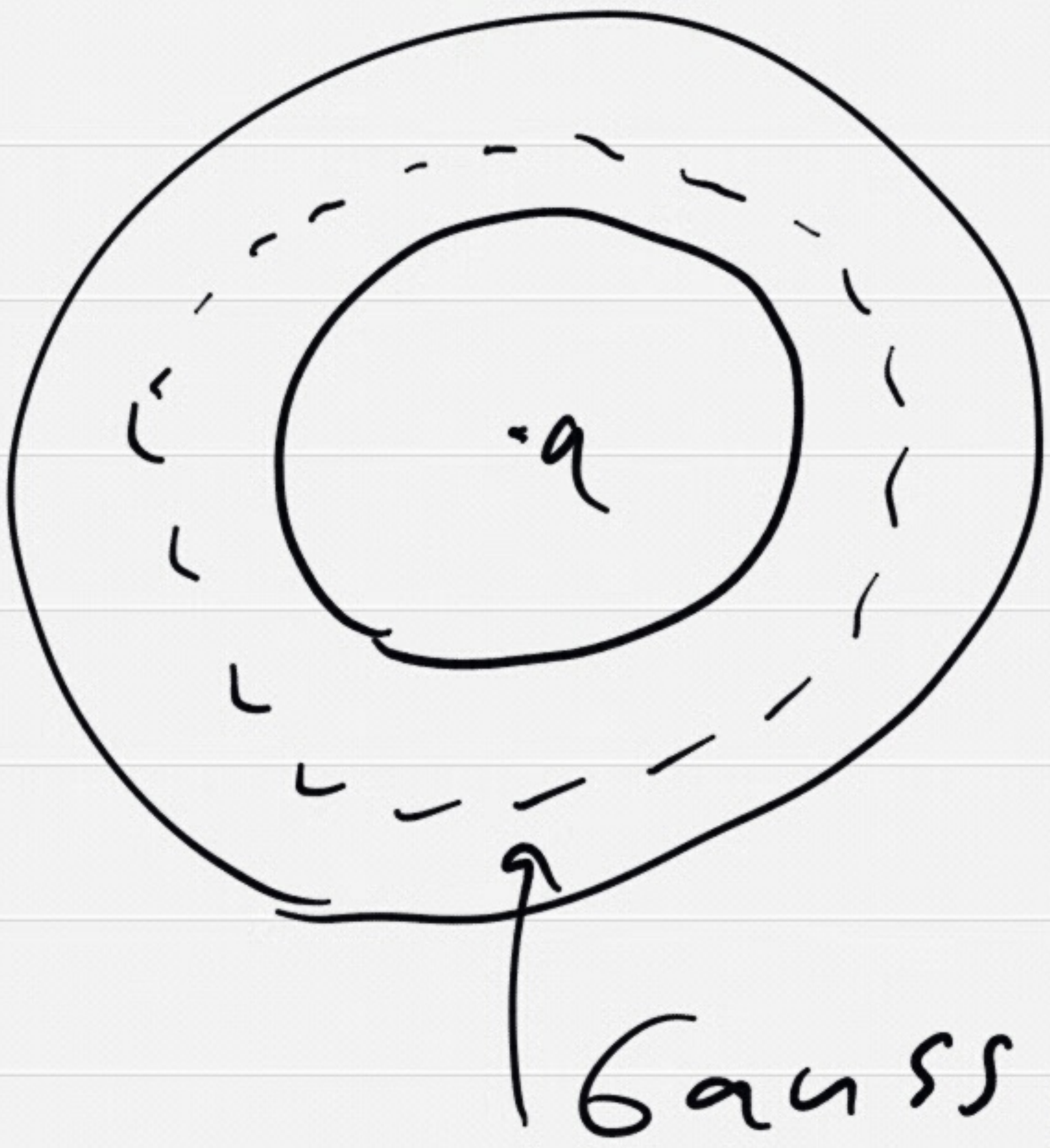


$\vec{E}$ induced

Total Field



- How much charge on walls?



$$\oint \vec{E} \cdot d\vec{a} = 0$$

since $\vec{E} = 0$

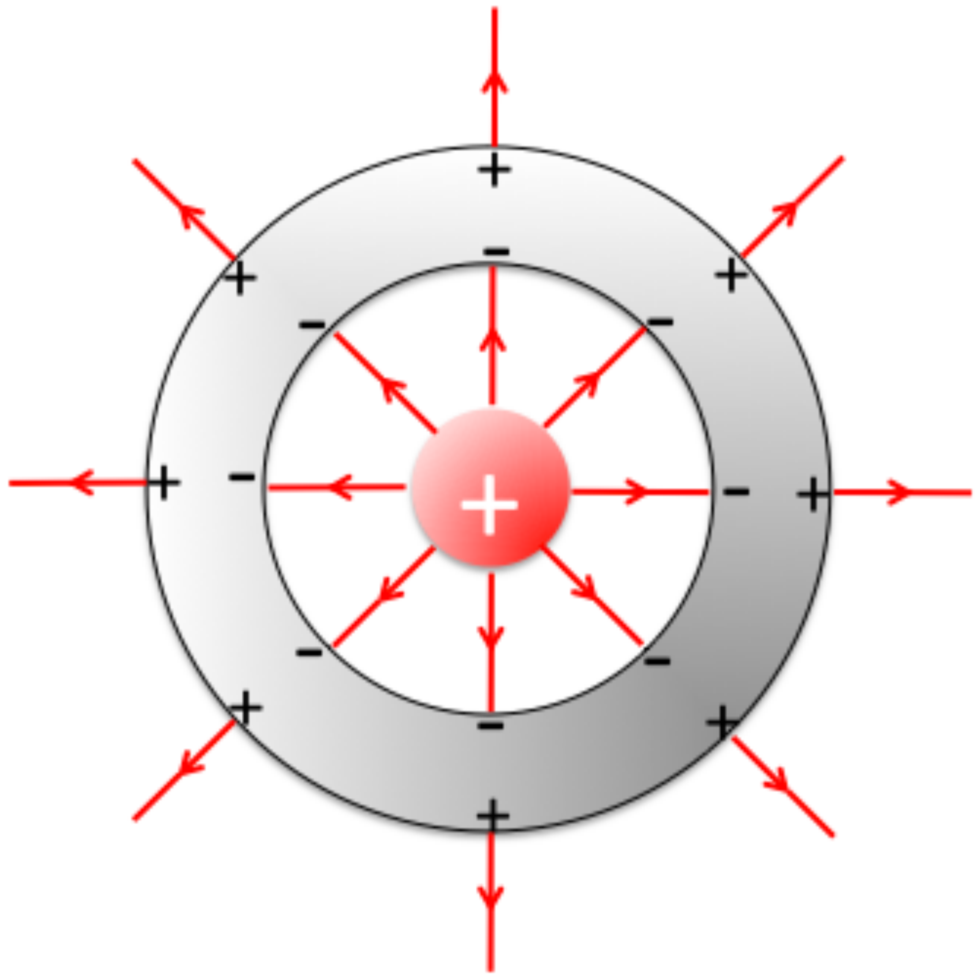
$\Rightarrow Q_{enc} = 0$

$\Rightarrow -q$ on inner wall

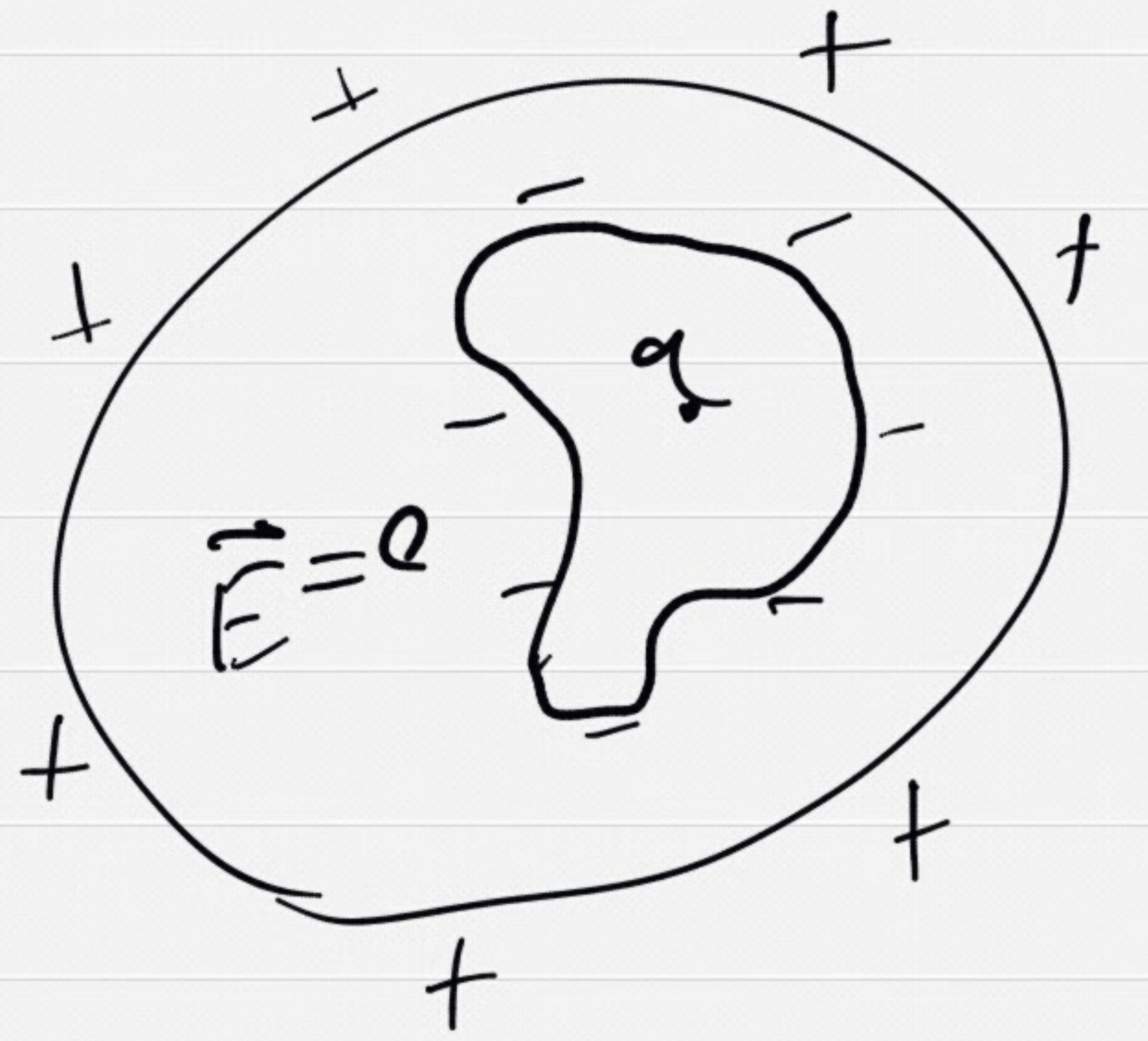
- If conductor net neutral

$\Rightarrow +q$ on outer wall

Conductor w/ Cavity



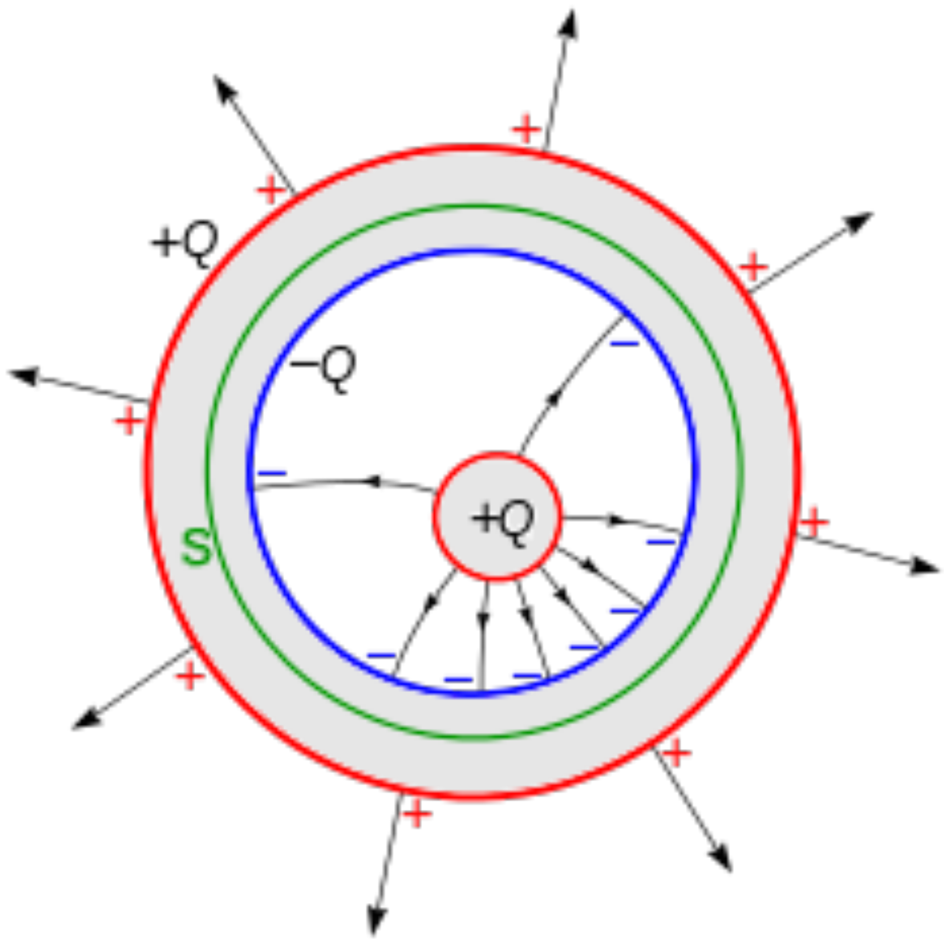
- Conductor w/ Irregular Cavity



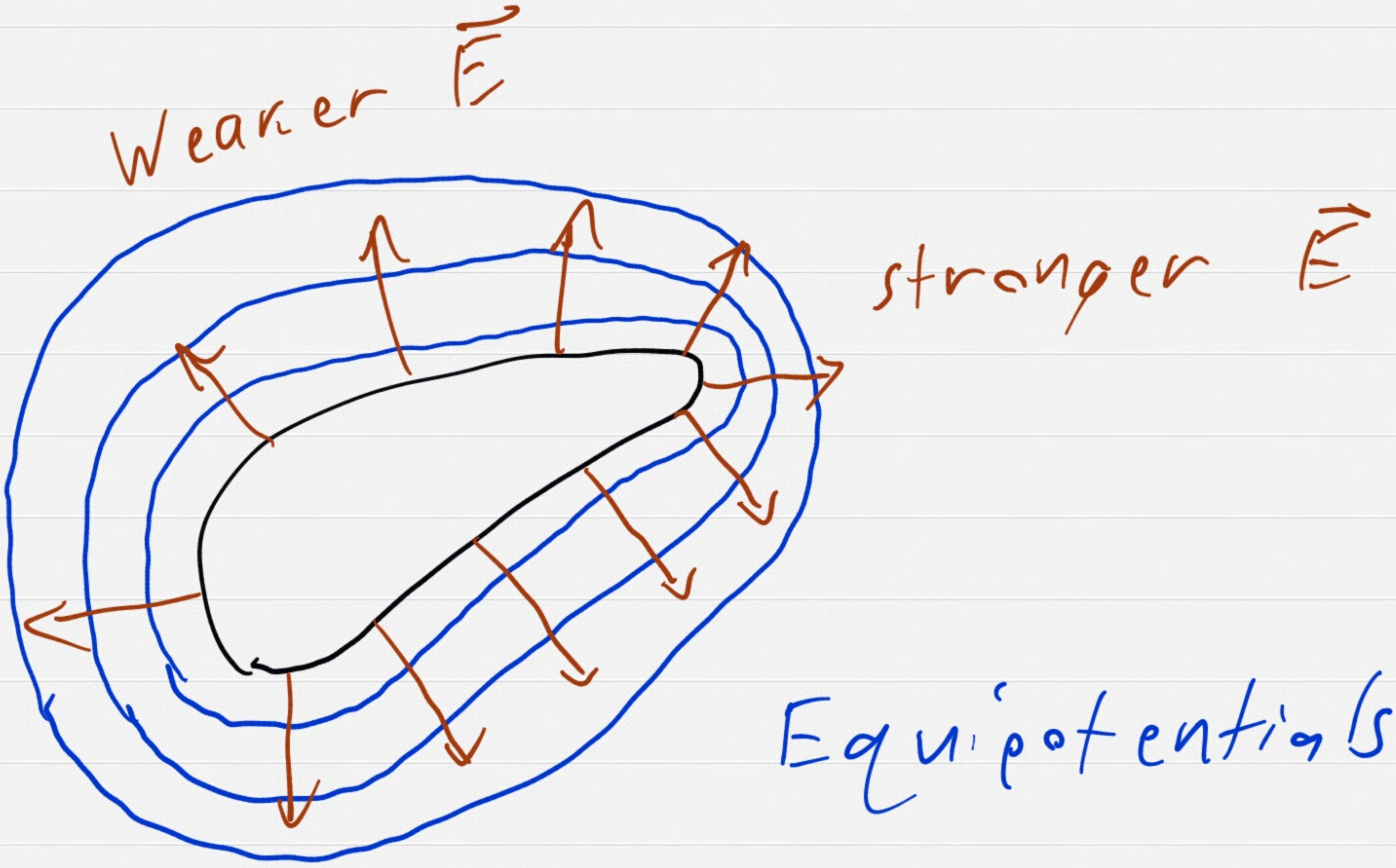
- charge on inner wall cancels field everywhere in conductor

- regardless of shape and location of cavity

Conductor w/ Cavity

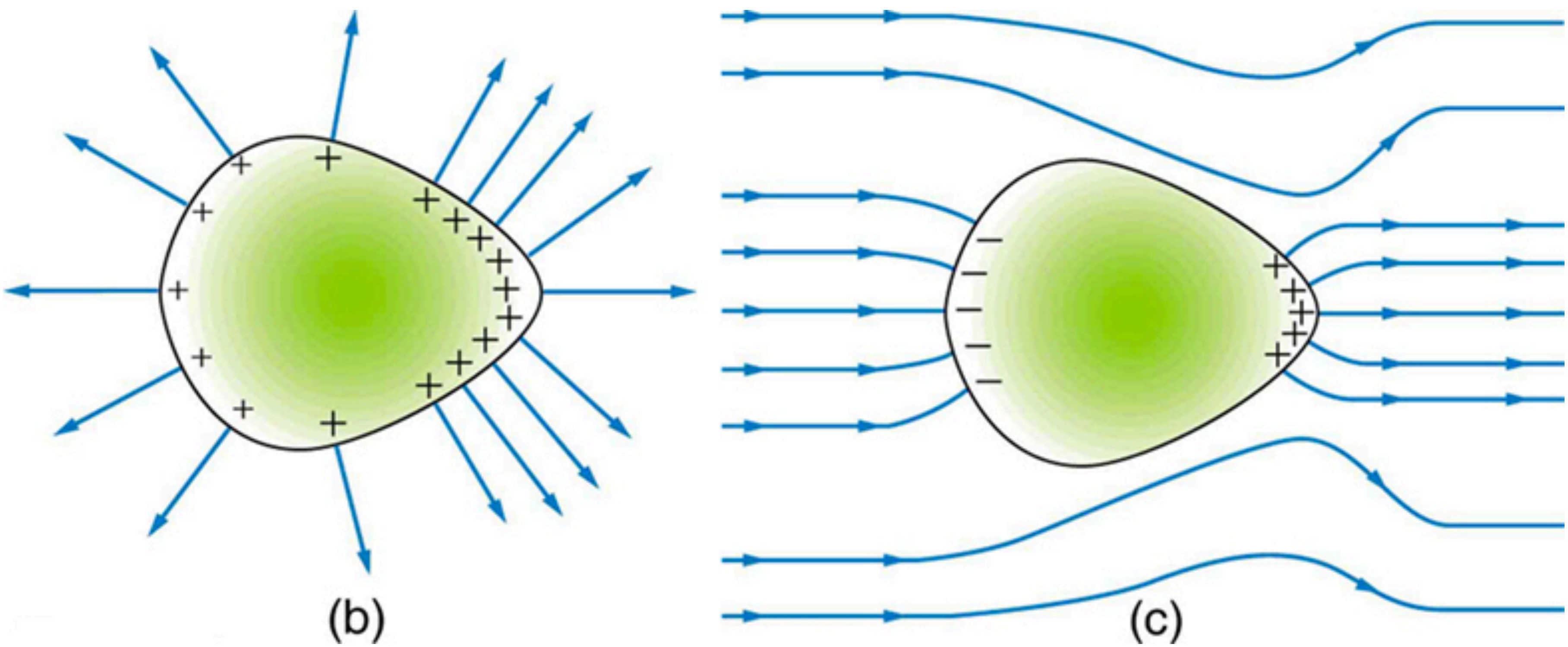


Non-Spherical Conductor



- Transition from tangent to surface to roughly spherical

Charge on Conductor



Force on Conductor

$$\Delta \vec{E} = \sigma/\varepsilon_0 \, \hat{n}$$

$\Rightarrow \vec{E}_{out} = \frac{\sigma}{\varepsilon_0} \hat{n}$ outside of conductor

$$\Rightarrow \sigma = \varepsilon_0 E_{out}$$

Force on charge

Force/area $\vec{f} = \vec{F}/A$

$$= Q\vec{E}/A$$

$$= \sigma \vec{E}$$

w/ $\vec{E} = \vec{E}_{ave} = \dfrac{\vec{E}_{out} + \vec{E}_{in}}{2}$

$$= \vec{E}_{out}/2$$

$$= \sigma/2\varepsilon_0 \, \hat{n}$$

$$\vec{f} = \sigma \vec{E}_{ave} = \boxed{\sigma^2/2\varepsilon_0 \, \hat{n}}$$

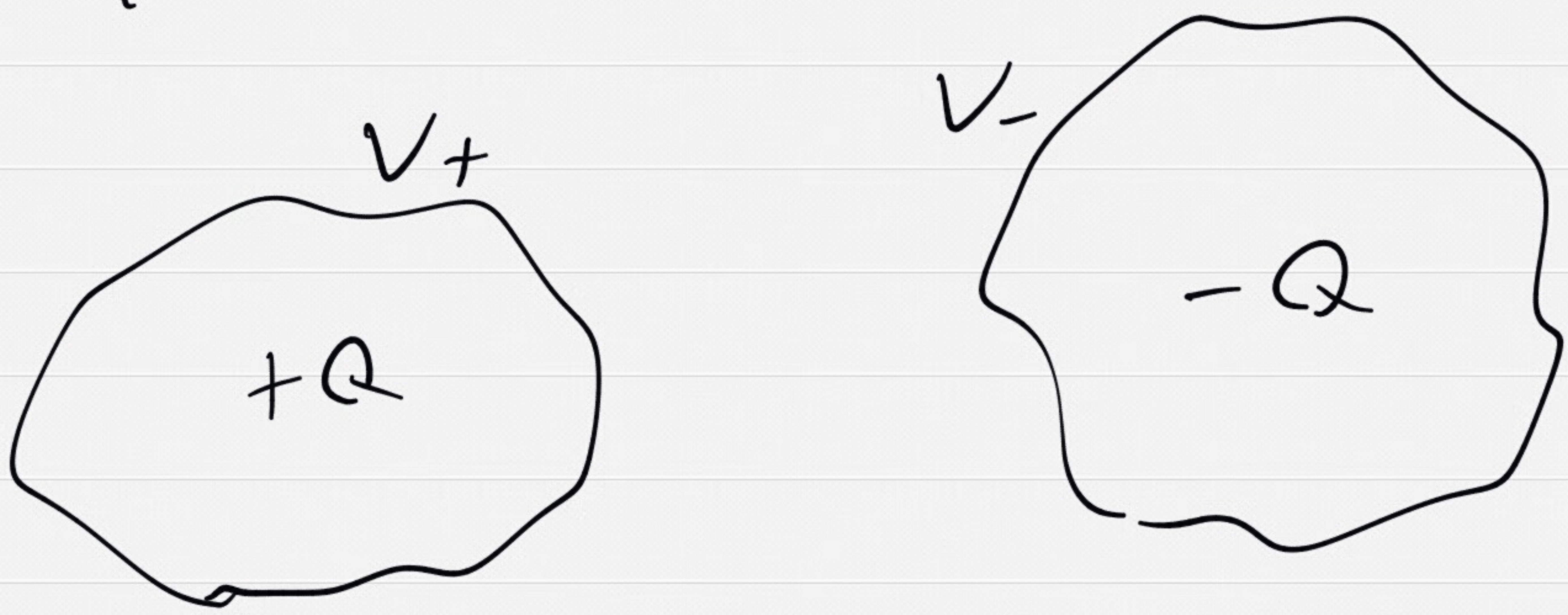
outward electrostatic pressure!

$$P = |\vec{f}| = \sigma^2/2\varepsilon_0 = (\sigma/\varepsilon_0)^2 \cdot \varepsilon_0/2$$

$$= \tfrac{1}{2} \varepsilon_0 E_{above}^2$$

pressure $\longleftrightarrow$ energy density

Capacitors



$$\Delta V = V_+ - V_-$$

(sometimes sloppily written as V)

$$= -\int_-^+ \vec{E}\cdot d\vec{l}$$

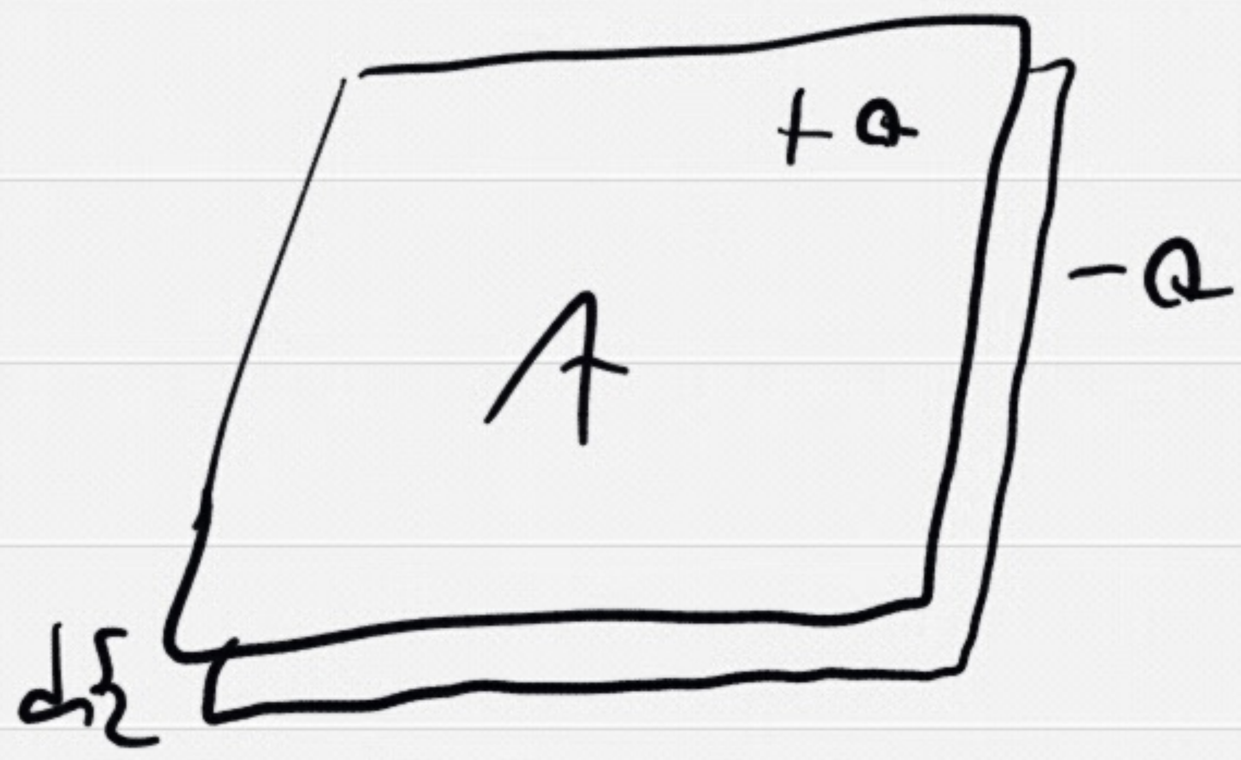
$$C \equiv Q/\Delta V$$

- since $\vec{E}$, V linear and thus proportional to Q

$\Rightarrow C =$ constant

depends only on geometry

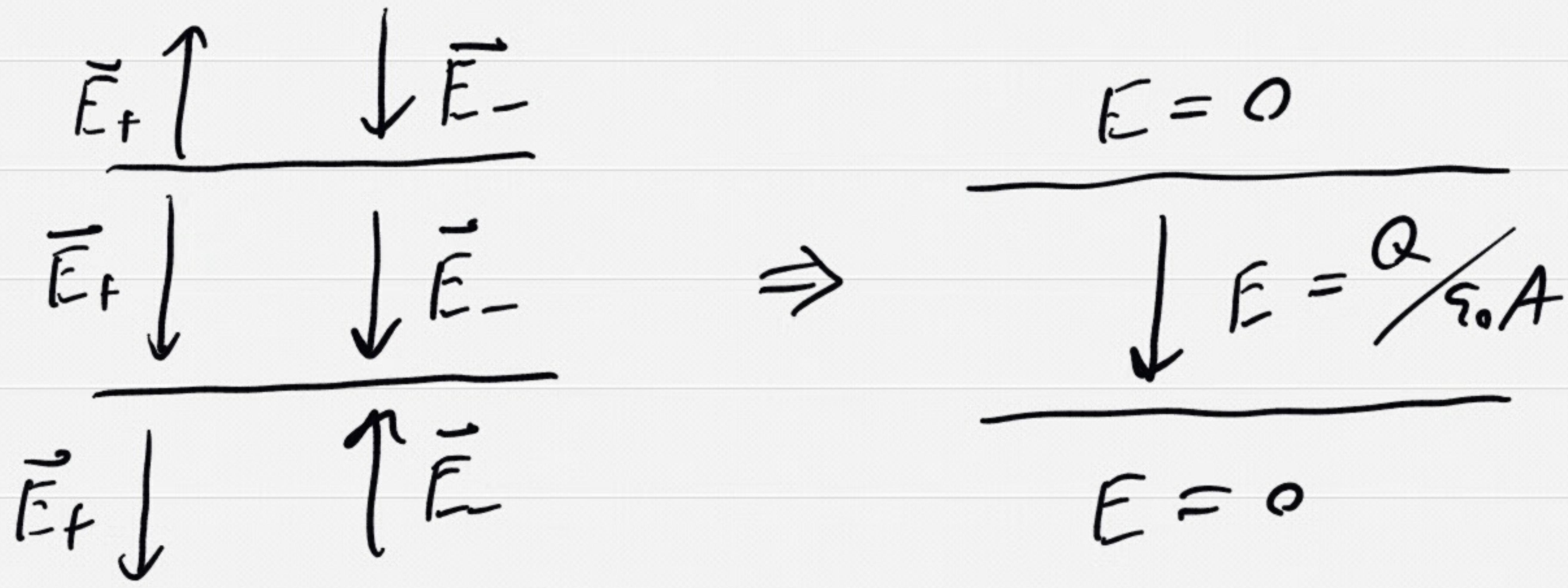
Parallel-Plate Capacitor



For $A \gg d^2$

$$\vec{E}_+ = \sigma_+/2\varepsilon_0 \, \hat{n}_+ = \frac{Q}{2\varepsilon_0 A}\hat{n}_+$$

$$\vec{E}_- = \sigma_-/2\varepsilon_0 \, \hat{n}_- = -\frac{Q}{2\varepsilon_0 A}\hat{n}_-$$



$$\Delta V = -\int \vec{E} \cdot d\vec{l} = E \cdot d = Qd/\varepsilon_0 A$$

$$\boxed{C = Q/V = \varepsilon_0 A/d}$$