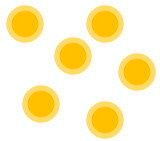
Mon.	2.5 Conductors		
Wed.	3.1-.2 Laplace & Images	*Poster Session: Hedco7pm~9pm*	
Thurs.			HW3
Fri.	Review		
Mon.	**Exam 1 (Ch 2)**		

Work to construct charge distribution

Source charges

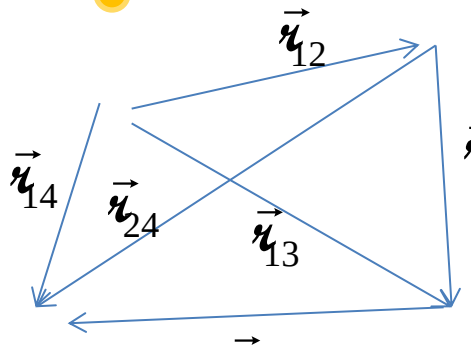
sensing charge, Q



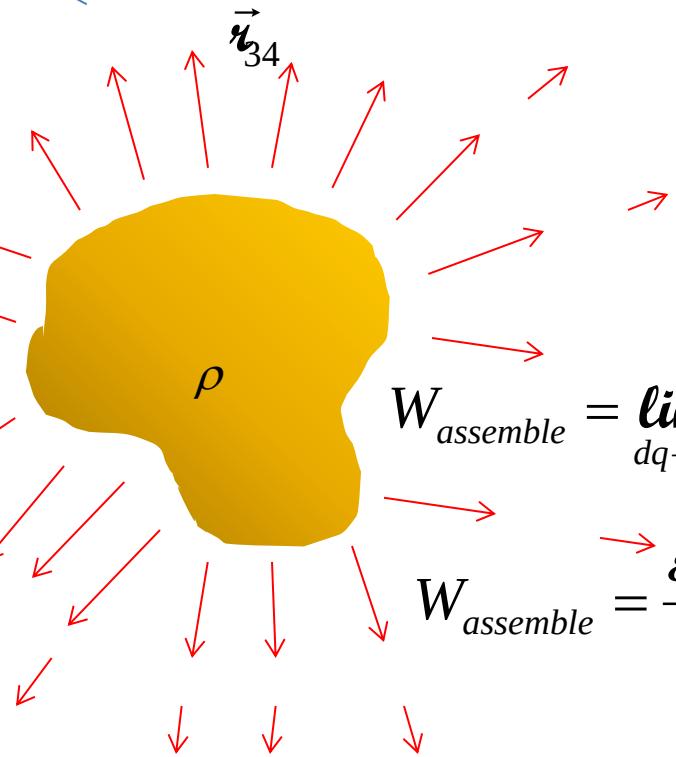
$$W(a \to b) = \int_a^b \vec{F}_{you} \cdot d\vec{l} = Q\left(-\int_a^b \vec{E} \cdot d\vec{l}\right) = Q\Delta V$$

a

b



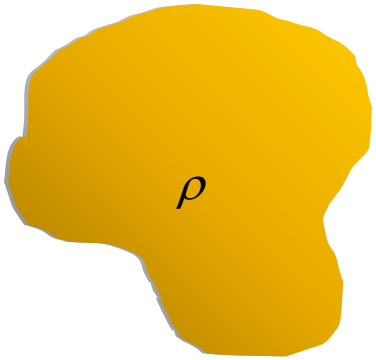
$$W = \sum_{i=2}^{n}\sum_{j=1}^{i-1} \frac{1}{4\pi\varepsilon_o}\frac{q_i q_j}{|\vec{r}_{ij}|} = \frac{1}{2}\left[\frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{n}\sum_{i\neq j}\frac{q_i q_j}{r_{ij}}\right] = \ldots = \frac{1}{2}\sum_{i=1}^{n} q_i V(P_i)$$



$$W_{assemble} = \lim_{dq\to 0}\frac{1}{2}\sum_{i=1}^{n} dq_i V(P_i) = \lim_{d\tau\to 0}\frac{1}{2}\sum_{i=1}^{n}(\rho d\tau)V(P_i) = \frac{1}{2}\int \rho V \, d\tau$$

$$W_{assemble} = \frac{\varepsilon_0}{2}\int_{\text{all space}} E^2 \, d\tau$$

‘building’ a Conductor



Properties of a Conductor

(i) *E* = 0 inside a conductor (eventually)

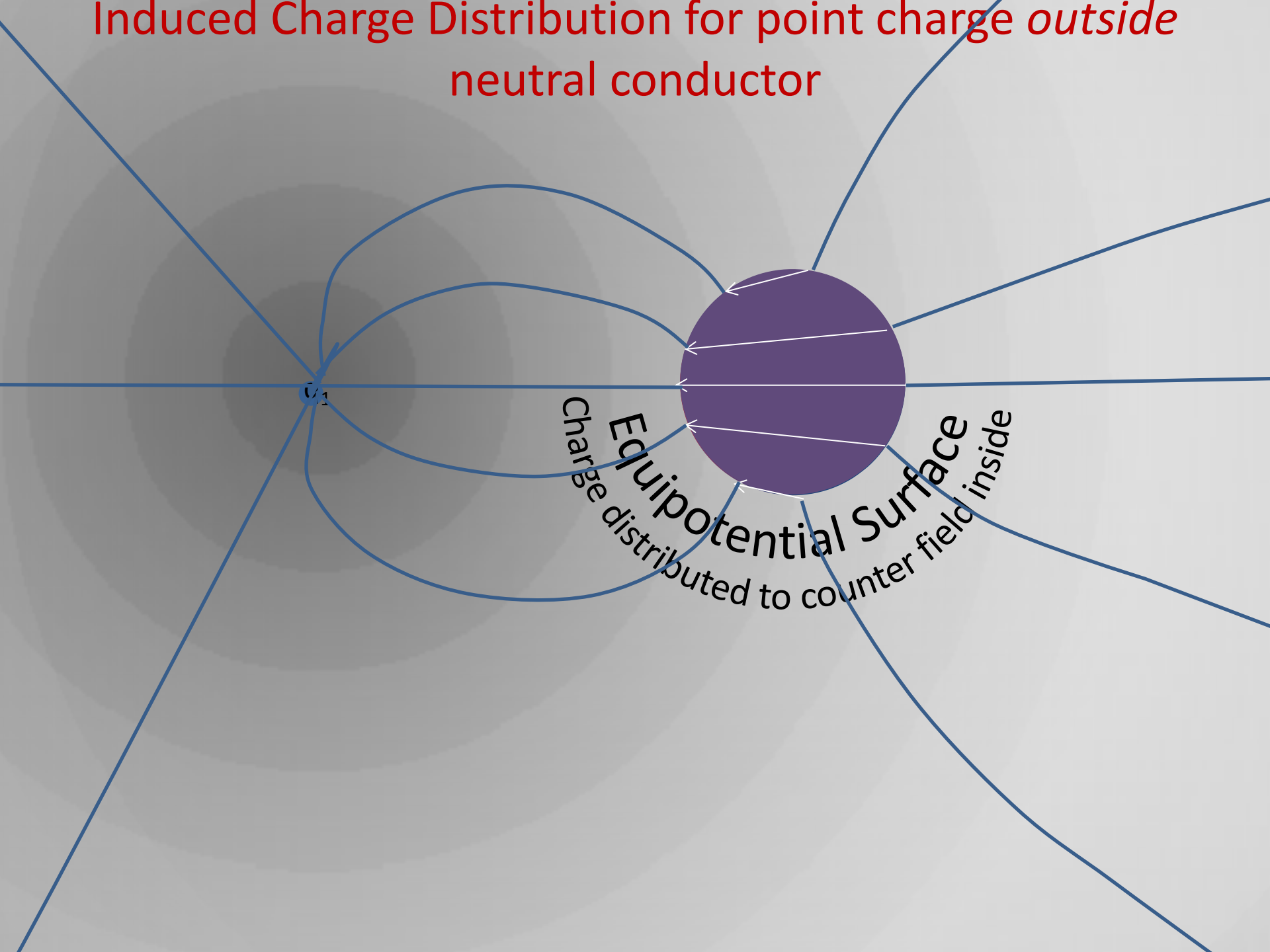
(ii) ρ =0 inside a conductor

(iii) Any net charge resides on the surface(s) of a conductor

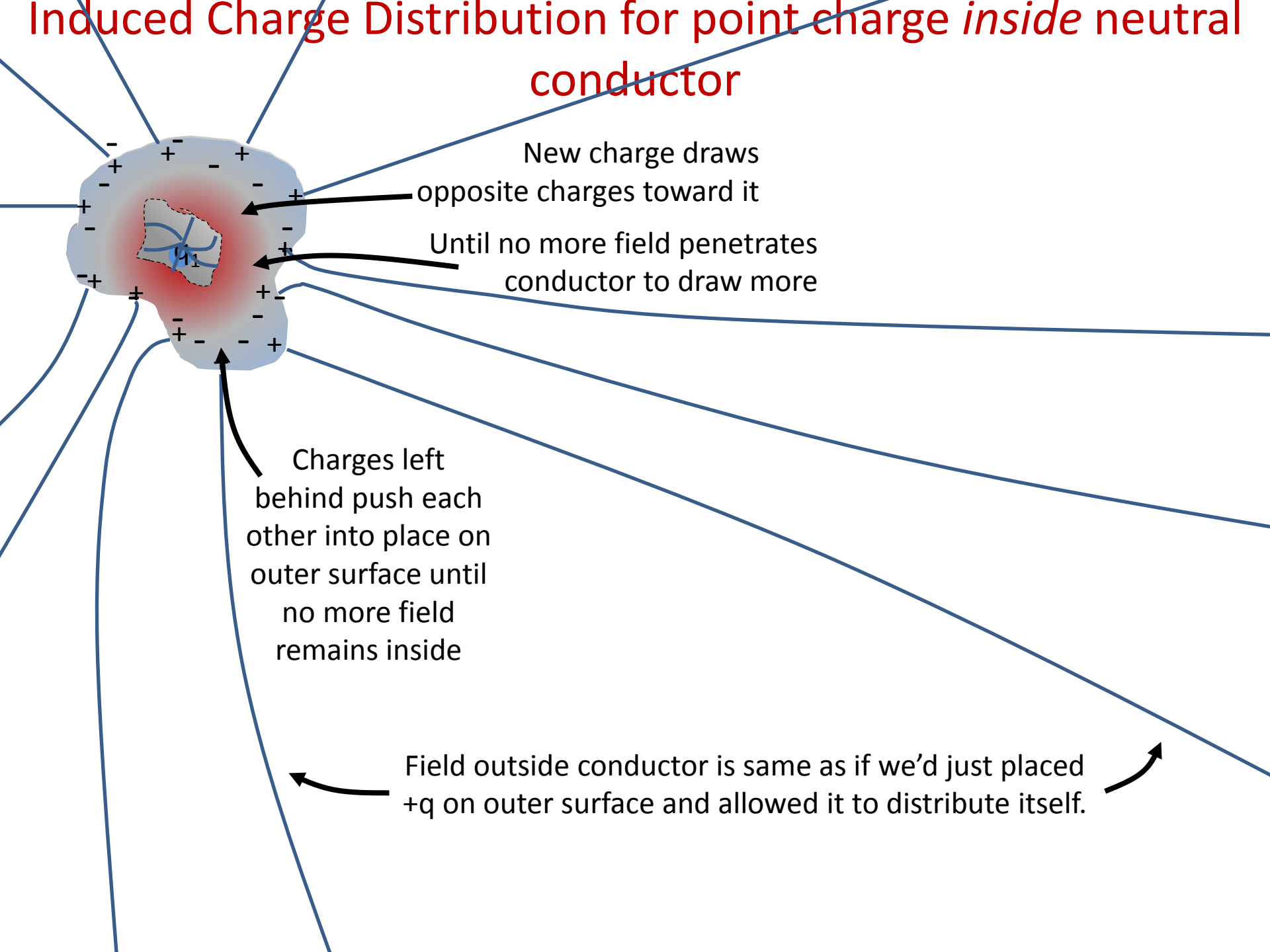
(iv) *V* is constant throughout a conductor

(v) $\vec{E}$ is perpendicular to the surface, just outside a conductor

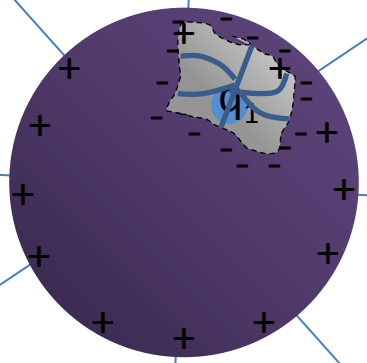
Induced Charge Distribution for point charge *outside* neutral conductor



Induced Charge Distribution for point charge *inside* neutral conductor

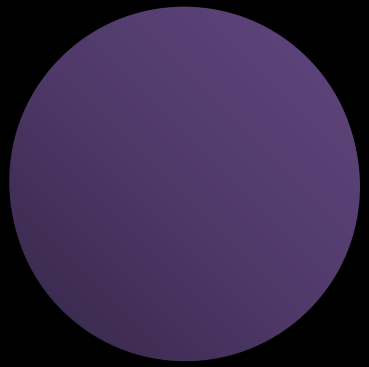


Induced Charge Distribution for point charge *inside* neutral conductor



Strength of external field dictated by added charge
Geometry of external field dictated by geometry of conductor surface
not location of added charge

Exercise:



(problem 2.39) Two spherical cavities, of radii *a* and *b,* are hollowed out from the interior of a (neutral) conducting sphere of radius *R*. At the center of each cavity a point charge is placed – call these charges q_a and q_b.

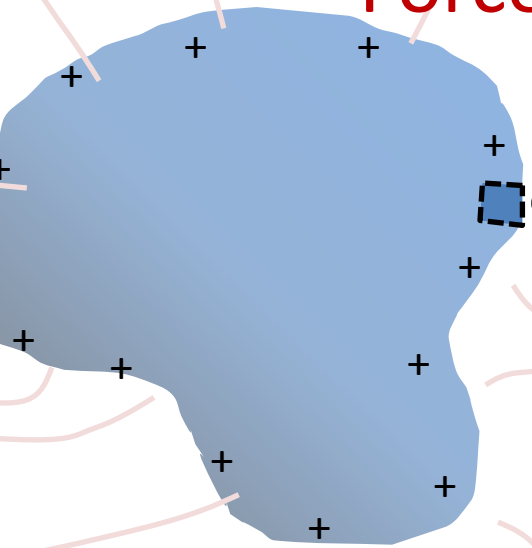
(a) Find the surface charge densities σ_a, σ_b, and σ_R.

(b) What is the field outside the conductor?

(c) What is the field within each cavity?

(d) What is the force on q_a, that on q_b?

Force on patch of Surface Charge



q_1

$$d\vec{F}_{\to dq} = (dq)\vec{E}_{other.@.patch}$$

$$\vec{E}_{other@patch} = \vec{E}_{total@patch} - \vec{E}_{patch@patch}$$

$$\vec{E}_{total@patch} \to 0_{inside}$$

$$\vec{E}_{patch@patch} \to \frac{\sigma}{2\varepsilon_o}\hat{n}_{in}$$

$$\vec{E}_{other@patch} = -\frac{\sigma}{2\varepsilon_o}\hat{n}_{in} = \frac{\sigma}{2\varepsilon_o}\hat{n}_{out}$$

$$d\vec{F}_{\to dq} = (dq)\frac{\sigma}{2\varepsilon_o}\hat{n}_{out}$$

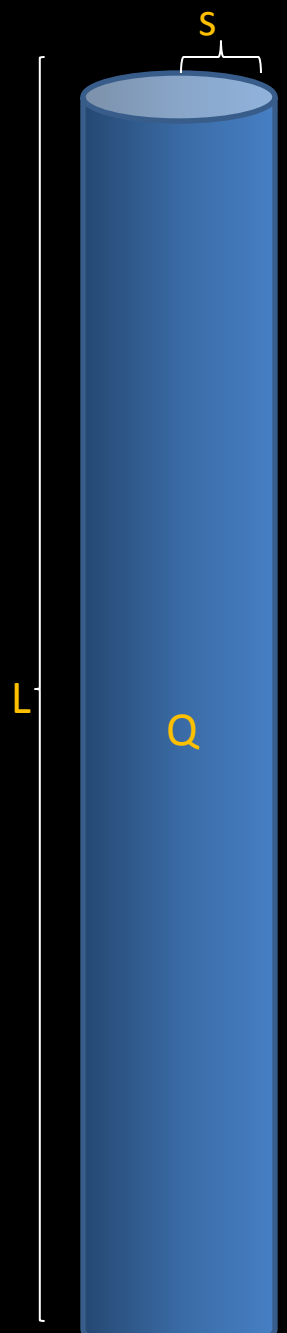
$$dq = \sigma da$$

$$d\vec{F}_{\to dq} = (da)\frac{\sigma^2}{2\varepsilon_o}\hat{n}_{out} = (da)2\varepsilon_o E^2_{other@patch}\hat{n}_{out}$$

$$\vec{P}_E \equiv \frac{d\vec{F}_{\to dq}}{da} = \frac{\sigma^2}{2\varepsilon_o}\hat{n}_{out} = \frac{E^2_{patch}}{2\varepsilon_o}\hat{n}_{out}$$

Exercise:

A “very long” ,hollow, metal cylinder of radius *s* and length *L* carries a total charge Q. What is the outward electrostatic pressure due to all the charges repelling each other.

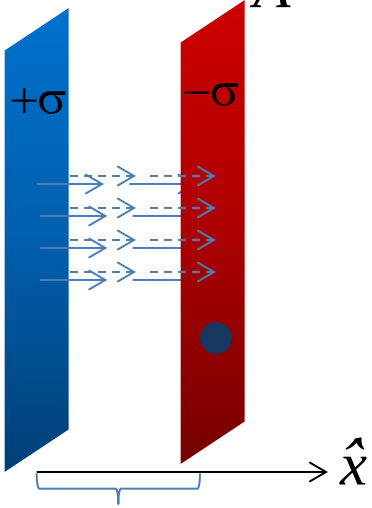


Capacitance

$$C \equiv \frac{Q}{\Delta V}$$

Example: Parallel Plates

$$\vec{E} = \frac{\sigma}{\varepsilon_o}\hat{x} = \frac{1}{\varepsilon_o}\frac{Q}{A}\hat{x}$$



$$\Delta V_{r\to l} = -\int_r^l \vec{E}\cdot d\vec{l} = \frac{1}{\varepsilon_o}\frac{Q}{A}d$$

$$C \equiv \frac{Q}{\Delta V_{r\to l}} = \frac{A}{\varepsilon_o d}$$

Exercise: concentric cylinders