Physics 142 - Sept. 27, 2007

- Exam 1 - One week from today

  Covers material on probsets 1-3

  Workshops 1-3

  - Exam Timing is poor in that we are ~½ thru "Potential". Problem Set 4 will involve more "potential" problems among other things.

  - Timing was better in 2005 in that we'd finished prob set 4

- Chpt 25 "potential" material is on exam and I will keep in mind that you've not yet done full set of chap. 25 problems.

Last time

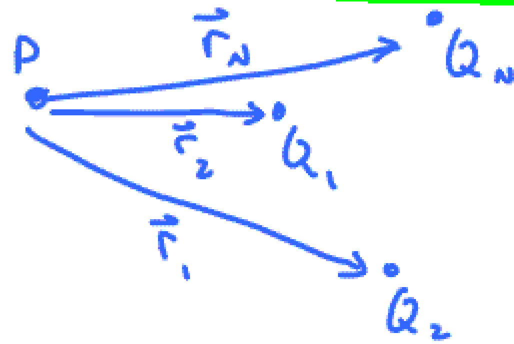
Electric Potential

pt. charge

$Q \xrightarrow{\vec{r}} P$

$$V_P = \frac{kQ}{r}$$

System of Discrete charges



$$V_P = \sum_i \frac{k Q_i}{r_i}$$

Important

Continuous charge

potential

$$V_P = \int_{vol} \frac{k\,dq}{r} = \int_{vol} \frac{k \rho\, dv}{r}$$

volume

Potential and the electric field

if $V = V(s)$

$$\boxed{E_s = -\frac{dV}{ds}}$$

if $V = V(x,y,z)$

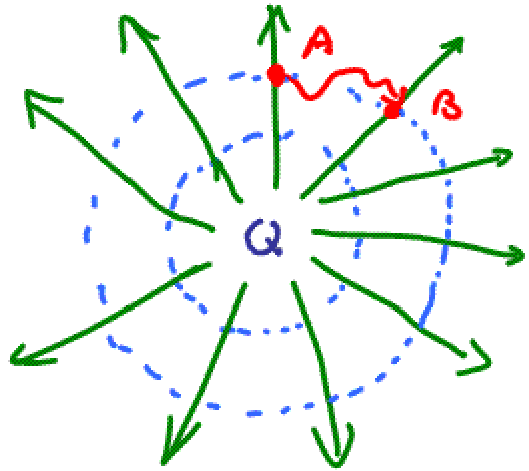
$$\boxed{\vec{E}(x,y,z) = -\vec{\nabla} V}$$

$$\vec{E}(x,y,z) = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$$

$\vec{\nabla} \equiv$ gradient ... vector operator

in cartesian coords

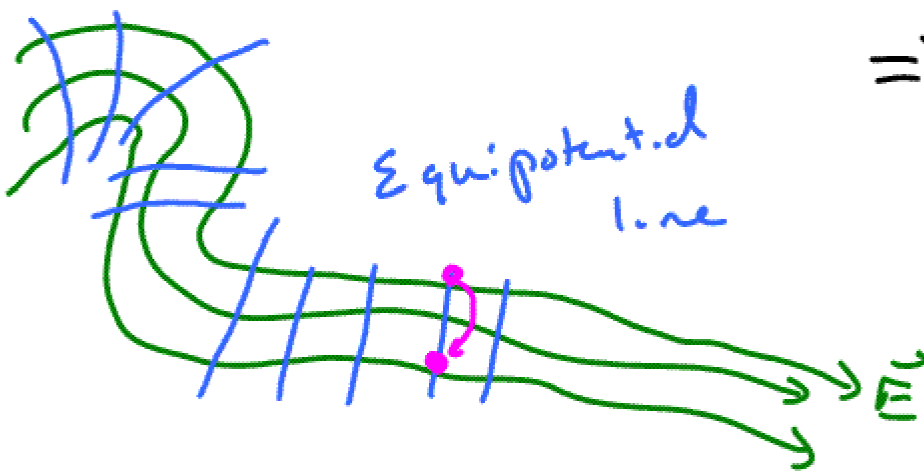
$$\vec{\nabla} \equiv \hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}$$



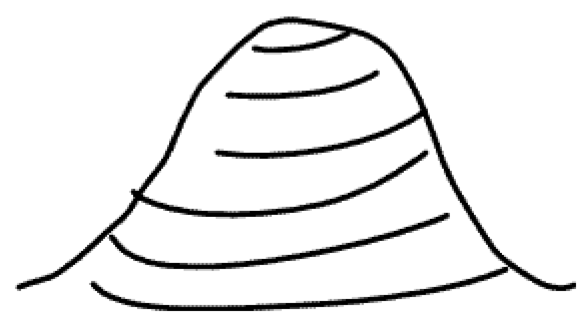
$$r_A = r_B$$

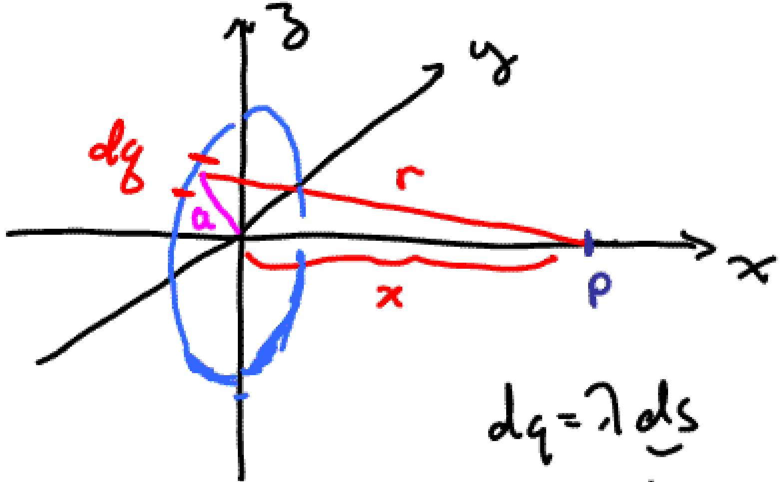
$$V_A = V_B$$

All pts at fixed radius are at same potential



$\Rightarrow$ Equipotential Surface





determine V_P and $\vec{E}_P$

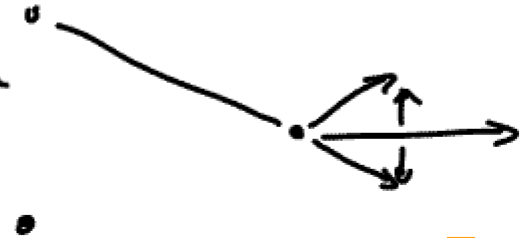
charge Q uniformly distributed on ring

$dq = \lambda \, ds$

Arclength

$r = \sqrt{x^2 + a^2}$

is CONSTANT



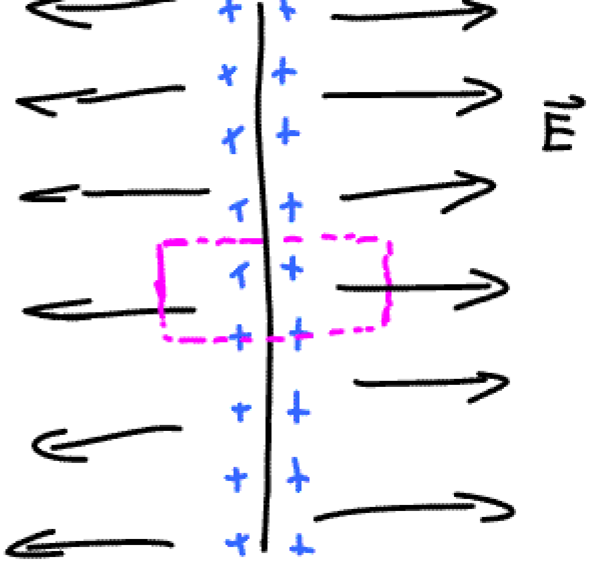
$\vec{E}$ along $\hat{x}$

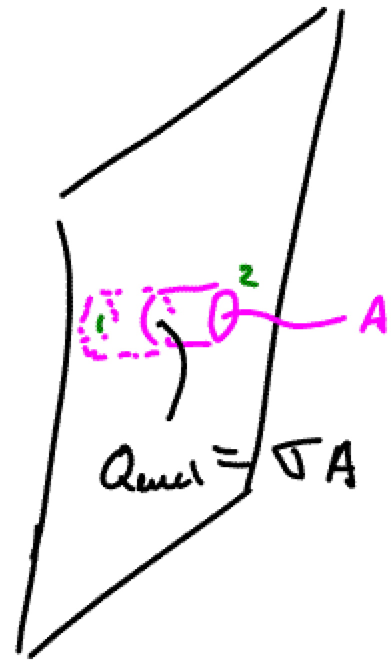
$$V_P = \int \frac{k\,dq}{r} = \frac{k\lambda}{\sqrt{x^2+a^2}} \int_0^{2\pi a} ds = \frac{k \overbrace{\lambda\, 2\pi a}^{Q}}{\sqrt{x^2+a^2}} = \frac{kQ}{\sqrt{x^2+a^2}}$$

$x \gg a \quad V \to \frac{kQ}{x}$ V of pt charge ✓

$$\vec{E}_P = -\frac{d V_P}{dx}\hat{x} = \frac{kQx}{(x^2+a^2)^{3/2}}\hat{x}$$

large x $\quad \vec{E}_P \to \frac{kQ}{x^2}\hat{x}$ ✓





∞ sheet of + charge

uniform charge density

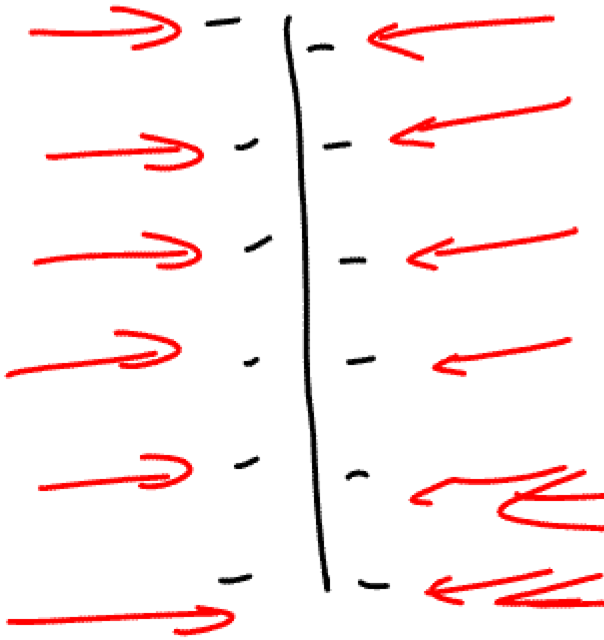
σ ~ coul./M^2

what is $\vec{E}$ as fn of σ?

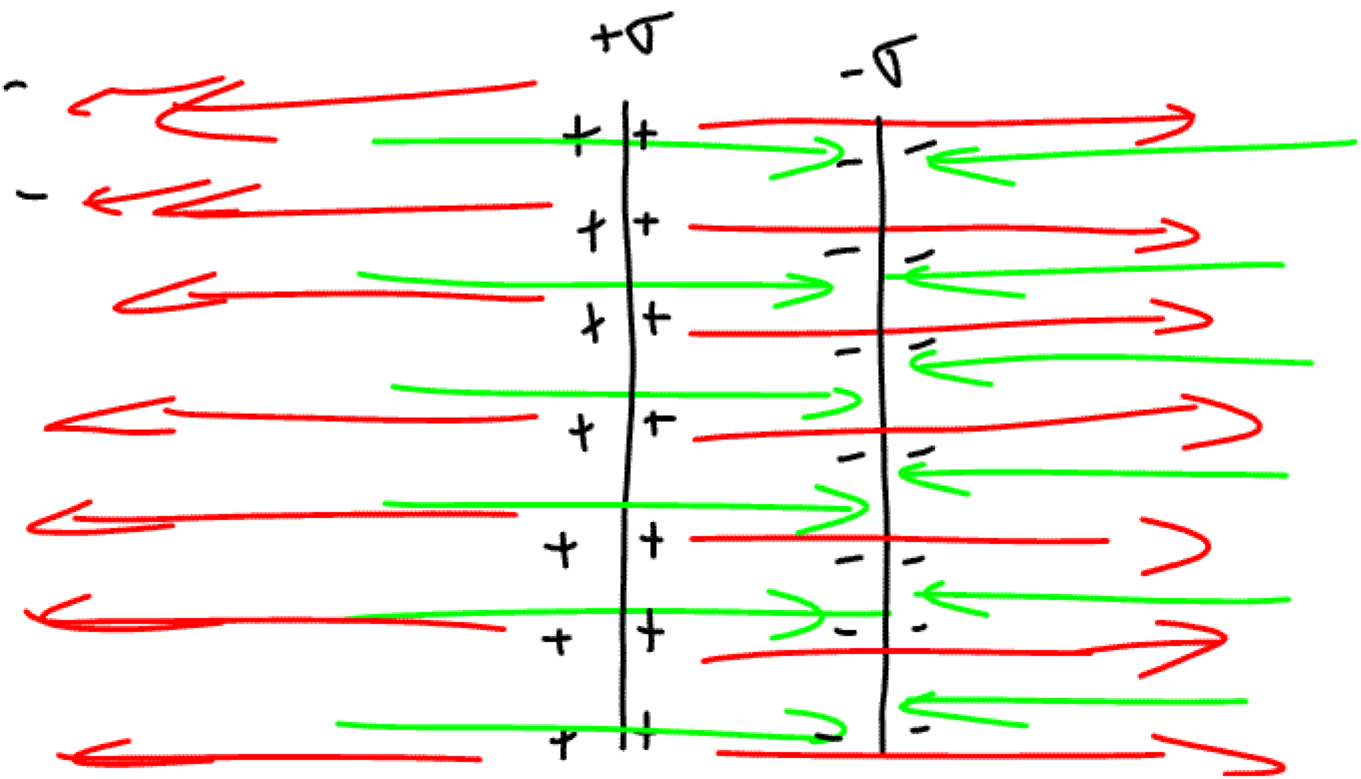
$$\oint \vec{E}\cdot d\vec{A} = \underbrace{\int_{\text{Pipe}} \vec{E}\cdot d\vec{A}}_{\substack{\vec{E}\perp d\vec{A} \\ 0}} + \underbrace{\int_{\text{Endcap 1}} \vec{E}\cdot d\vec{A} + \int_{\text{endcap 2}} \vec{E}\cdot d\vec{A}}_{2EA}$$

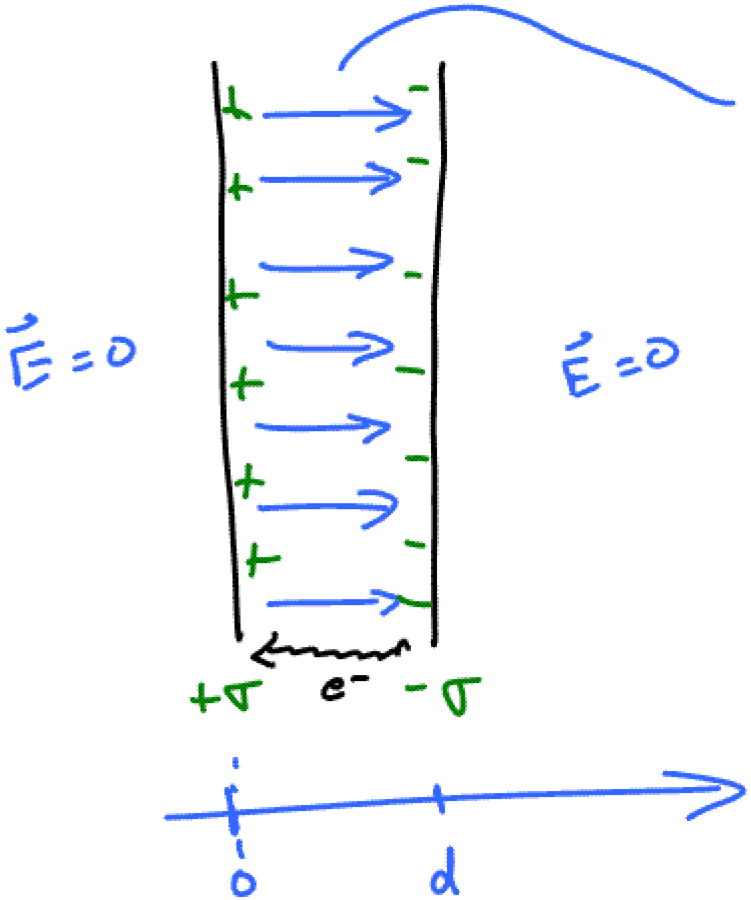
$$\oint \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0} \longrightarrow 2|\vec{E}|A = \sigma A/\epsilon_0$$

$$|\vec{E}| = \frac{\sigma}{2\epsilon_0}$$



$$|\vec{E}| = \sigma/2\epsilon_0$$





$$|\vec{E}| = \frac{\sigma}{\epsilon_0}$$

parallel plate capacitor

$$V_{\text{between plates}} = -\int \vec{E}\cdot d\vec{s}$$

$$= -|E|d$$

$$= \frac{\sigma d}{\epsilon_0}$$

$\Delta V = 1$ volt

$eV \equiv$ 1 electron-Volt of energy / work to move e from 1 plate to other

$$1\ eV = (1|e|)(1\ volt) = 1.6\times10^{-19}\ coul/volt$$

$$= 1.6\times10^{-19}\ \text{Joules}$$

$E = mc^2$

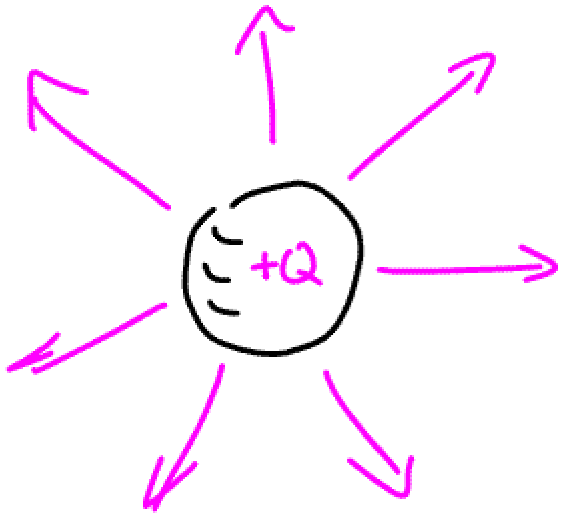
eV

unit of Mass $= eV/c^2$

MeV/c^2

Each sphere has Radius R

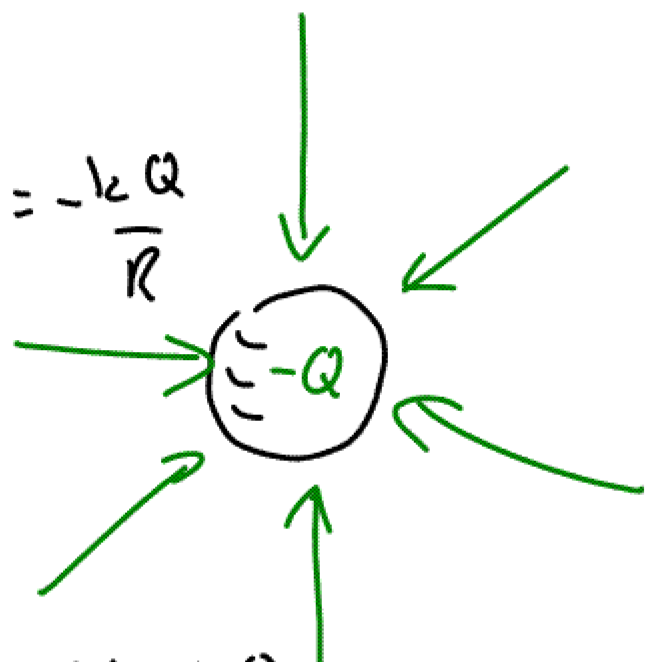
Far Apart



$$V_+ = \frac{kQ}{R}$$

$$V_+ \propto Q$$

$$V_- = -\frac{kQ}{R}$$



$$V_\pm = V_+ - V_- = \frac{2kQ}{R}$$

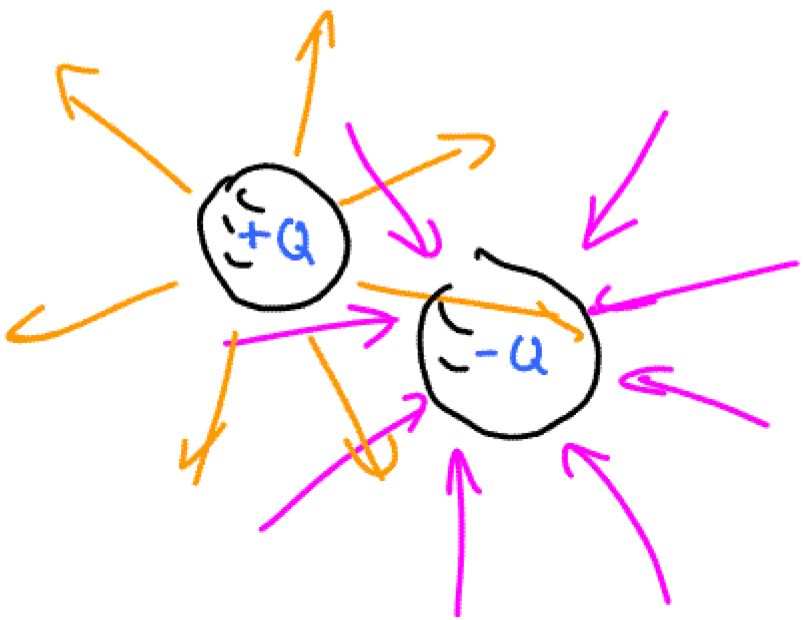
$$V_\pm \propto Q$$

$$V_- \propto Q$$

define $\underline{\underline{\text{capacitance}}}$ "C" as the const. of proportionality

$Q = C_+ V_+$ $\qquad$ $Q = C_- V_-$

$$Q = C_{+-} V_{+-}$$

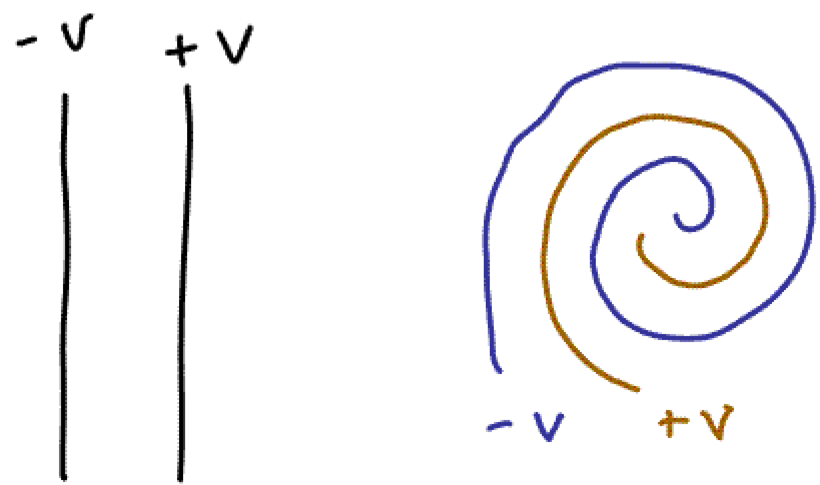


New geometry $|V_+|$, $|V_-|$, V_{+-} all reduced

$$Q = (C_{+-})_{New} (V_{+-})_{New}$$

Capacitance quantifies amt of charge that system can hold at given potential difference

→ depends only on geometry



larger capacitance means more Q can be stored for same ΔV