Physics 142 – September 25, 2014

- Prob sets here ... Will be in box outside my office

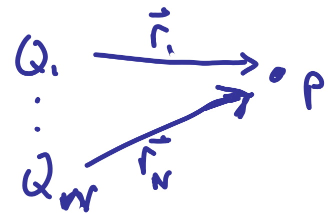
- Exam 1
  - Tuesday Oct. 7 Hoyt, During usual lecture time
  - Old exams on web
  - One side 8.5×11 inch sheet w/ notes formulas okay
  - Formula sheet included
  - Exact material coverage Announced soon

No Topological enhancements

Last Time

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

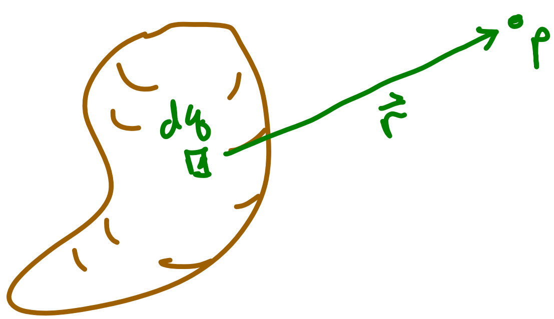
$$V_p = \sum_{i=1}^{N} \frac{kQ_i}{r_i}$$



$$V_p = \int_{\text{volume}} \frac{k\,dQ}{r} = \int_{\text{volume}} \frac{k\rho\,dV}{r}$$

V for potential

V for volume



can use potential to Find $\vec{E}$

$$E_s = -\frac{dV}{ds}$$ for generalized coordinates

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

$$\boxed{\vec{\nabla} \equiv \left(\frac{\partial}{\partial x}\right)\hat{i} + \left(\frac{\partial}{\partial y}\right)\hat{j} + \left(\frac{\partial}{\partial z}\right)\hat{k}}$$

Del

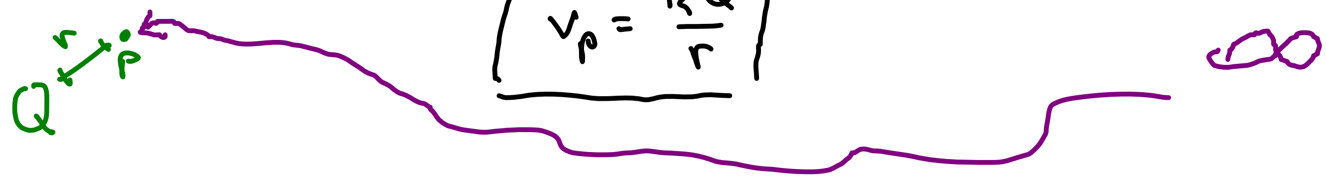
vector operator

$$\vec{E} = -\vec{\nabla} V$$
$$= -\text{grad } V$$

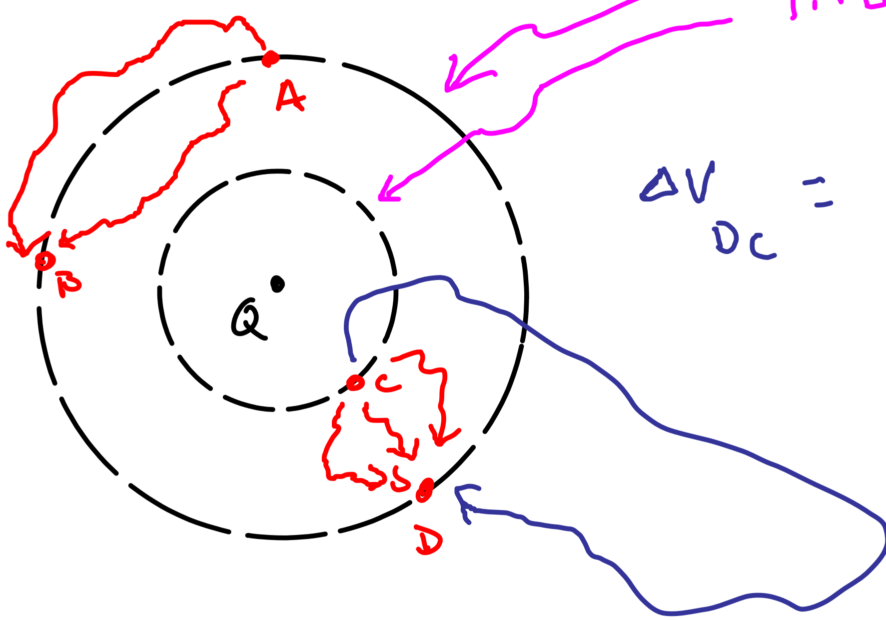
$\vec{E}$ is the gradient of the potential.

Note: V is a scalar field, $\vec{E}$ is a vector field

Gradient of a scalar field is a vector



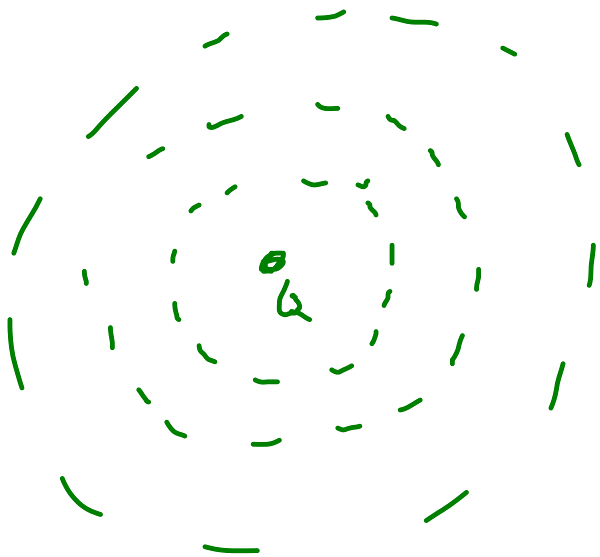
$$\boxed{V_P = \frac{kQ}{r}}$$

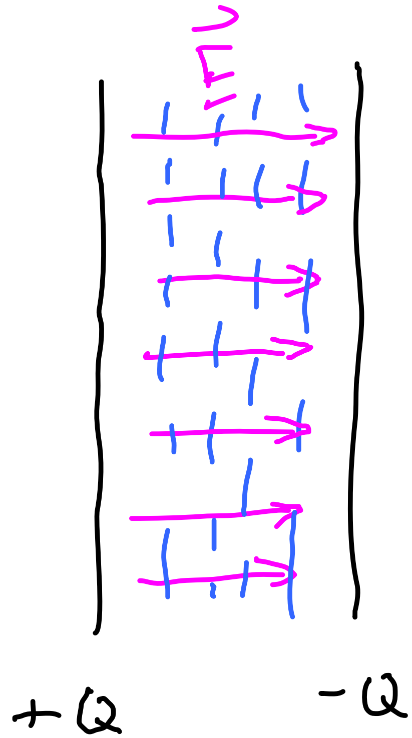


lines of equipotential

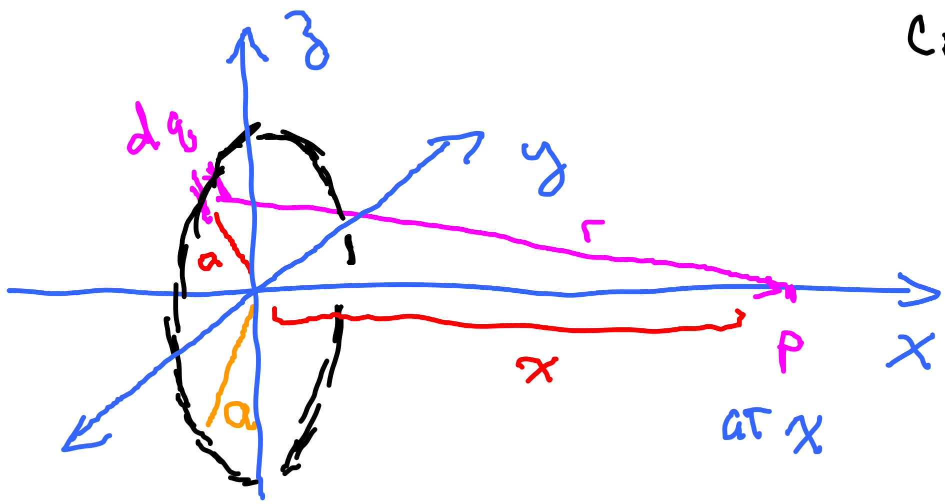
$\perp \vec{E}$

$$\Delta V_{DC} = \frac{kQ}{r_D} - \frac{kQ}{r_C}$$





$$\vec{E} = -\vec{\nabla} V$$



Circular ring of charge in xy plane centered at origin

find V_P and $\vec{E}_P$

λ constant

Q on ring $\quad \lambda = \dfrac{Q}{2\pi a}$

$$V_P = \int \frac{k\,dq}{r} = \frac{k}{r}\int_0^{2\pi a} \lambda\, ds \qquad r = (x^2+a^2)^{1/2}$$

$$V_P = \frac{k}{r}\lambda 2\pi a = \frac{kQ}{2\pi a}\frac{2\pi a}{(x^2+a^2)^{1/2}} = \frac{kQ}{(x^2+a^2)^{1/2}}$$

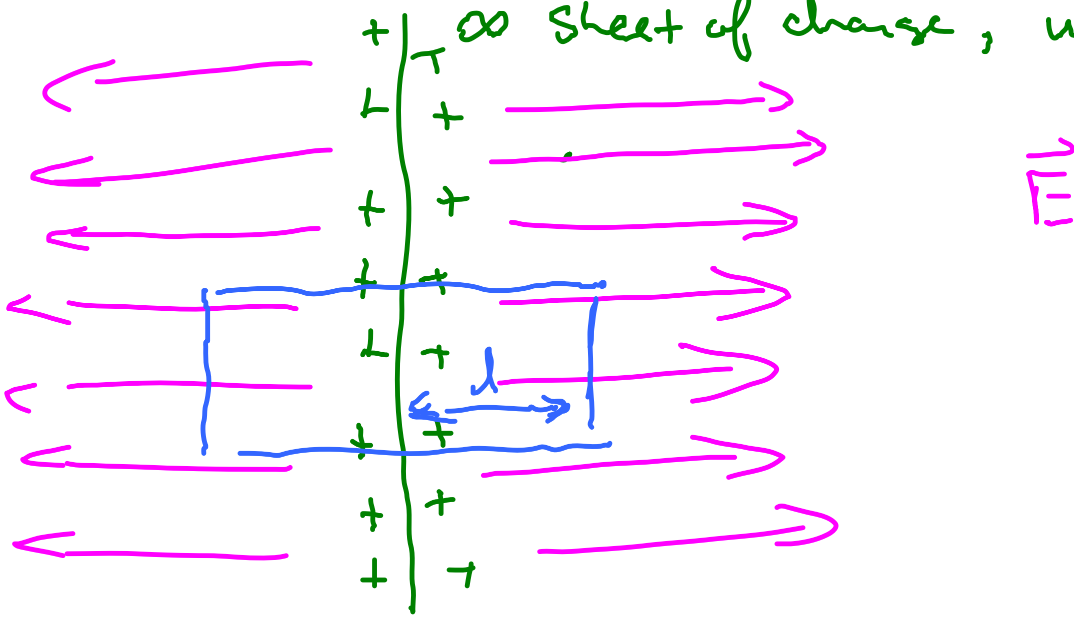
move to large x $\longrightarrow$ $\dfrac{kQ}{x}$. potential of pt charge Q ✓

$$\vec{E}_P = -\vec{\nabla} V = -\frac{d}{dx}\frac{kQ}{(x^2+a^2)^{1/2}}\hat{x} = \frac{kQx}{(a^2+x^2)^{3/2}}\hat{x}$$

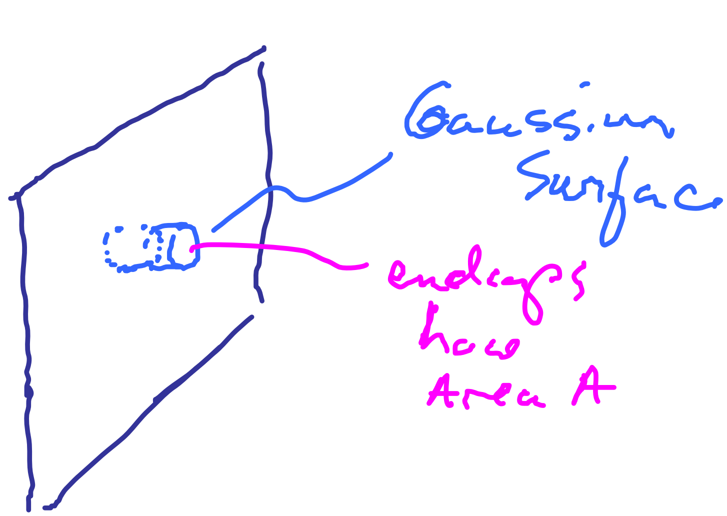
let $x \to \infty$ $\quad \vec{E} \to \frac{kQ}{x^2}\hat{x}$ ✓

∞ sheet of charge, uniform surface charge density σ

$\frac{\text{Coul}}{m^2}$



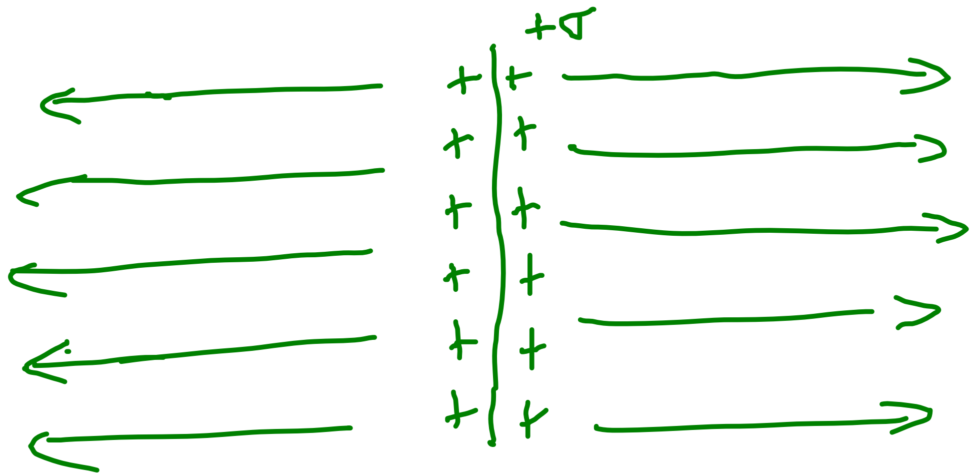
what is $\vec{E}$ as fn of distance from sheet

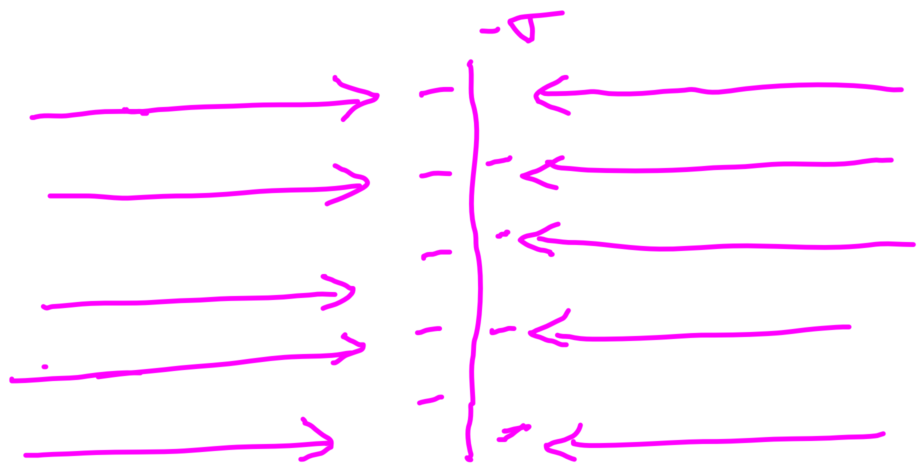


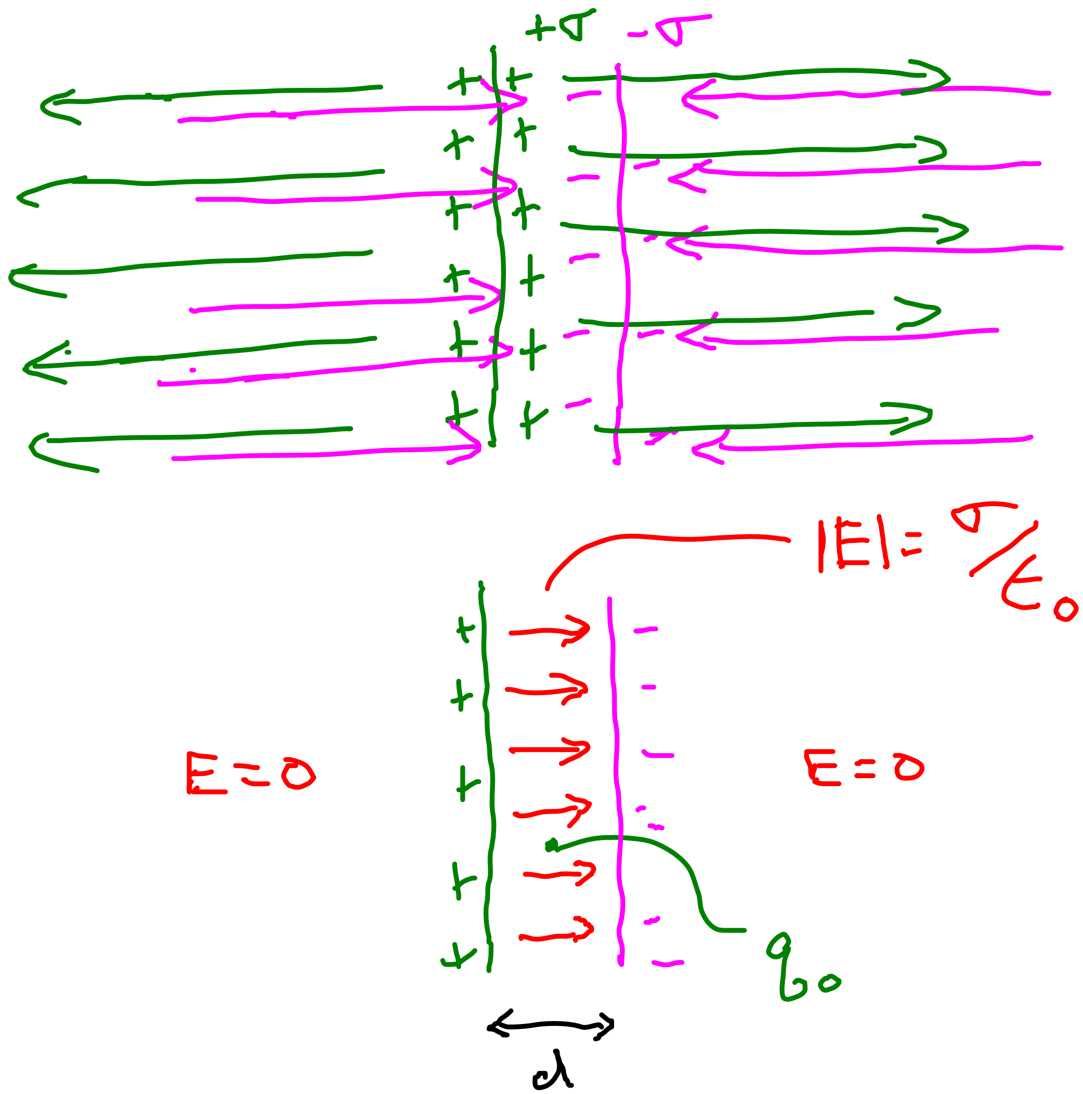
$$\oint \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

$$2EA = \frac{\sigma A}{\epsilon_0}$$

$$\boxed{E = \frac{\sigma}{2\epsilon_0}}$$


+σ


−σ

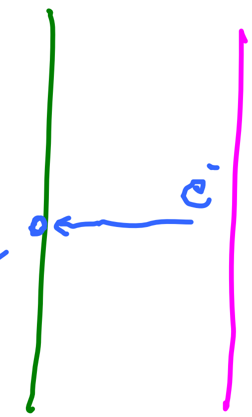


Parallel plate

$$\Delta V_{\text{bet plates}} = -\int \vec{E}\cdot d\vec{s} = -|E|\,d$$

$$|V| = \frac{\sigma}{\epsilon_0}\, d$$

$$|V| = 1 \text{ volt} \approx 1 \, \frac{\text{joule}}{C}$$



e^- has a kinetic energy

$$KE_{e^-} = 1 \text{ electron-volt} = 1\,eV$$

$$1\,eV = (1\,|e|)(1\text{ volt}) = 1.6\times 10^{-19}\, \underbrace{C \cdot 1 \text{ volt}}_{\text{joules}}$$

$E = mc^2$

eV

$$\frac{eV}{c^2} = \text{unit of mass}$$

$+Q$

2 charges
each w/ radius R

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

$V_+ \propto Q$

$V \propto Q$

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

$\Delta V_{\text{bet spheres}} = V_+ - V_- = \frac{2kQ}{R}$

$\propto Q$

$-Q$

$V \propto Q$

constant of proportionality

→ Capacitance $= C$

units Farads

depends only on geometry

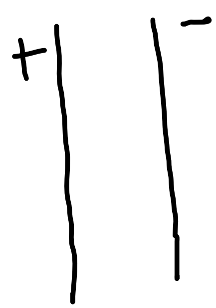
$Q_+ = C_+ V_+$

$Q_- = C_- V_+$

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

$$\boxed{Q = CV}$$

depends on geometry



$C \equiv$ Capacitance Farads

$C \equiv$ speed of light m/s

$C \equiv$ charge in coulombs

$C \equiv$ Calorie

$C \equiv$ heat capacity