Note Title 1/13/2010

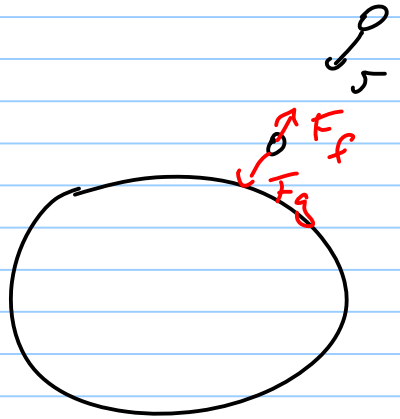
Problem Solving Strat.

I NEWTON'S LAWS $\vec{F} = m\vec{a}$

1.) $\vec{F} = m\vec{a}$

2.) Lagrange

3.) Hamilton's



II Conservation Laws

- Energy
- mom
- charge

$$\vec{F} = m\vec{a} = q\vec{E} + q\vec{v} \times \vec{B}$$

also to find $\vec{E}$ & $\vec{B}$

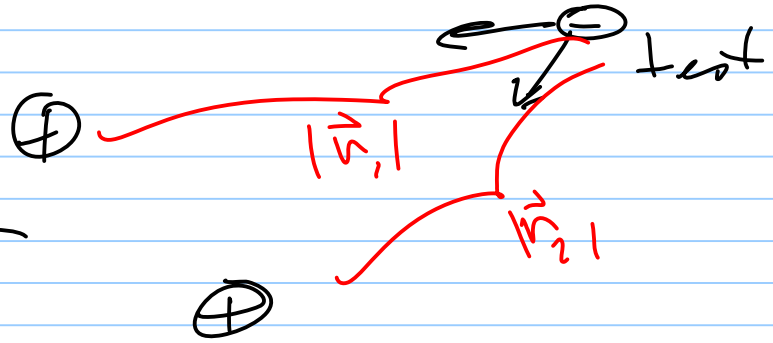
Statics

Coulomb force: $\vec{F} = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}\hat{r}$

$2+\delta$ $\quad \delta \leq 10^{-16}$

$q_{proton} = q_{electron}$ to 1 part in 10^{20}

Superposition Prin.

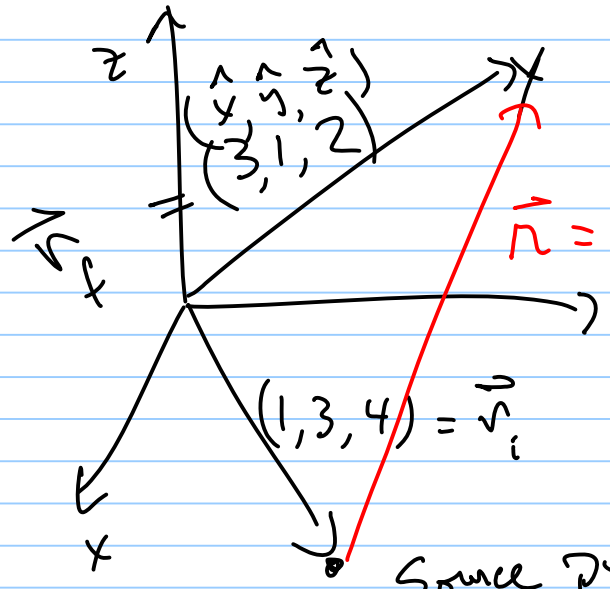


$$\vec{F}_{\ominus} = \frac{1}{4\pi\epsilon_0}\frac{(q_+)(q_-)}{r_1^2}\hat{r}_1 + \frac{1}{4\pi\epsilon_0}\frac{(q_-)(q_+)}{r_2^2}\hat{r}_2$$

$$= q_- \left(\frac{1}{4\pi\epsilon_0} \frac{q_+}{r_1^2} \hat{r}_1 + \frac{1}{4\pi\epsilon_0} \frac{q_+}{r_2^2} \hat{r}_2 \right)$$

$$\vec{E}$$

$$\vec{E} = \sum_i \vec{E}_i \rightarrow \int d\vec{E}$$



field pt

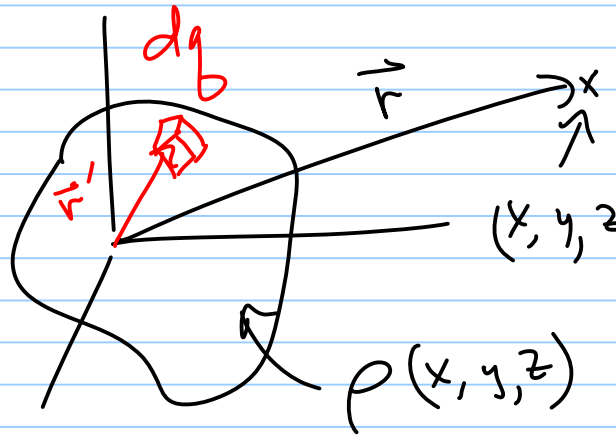
$$\vec{r} = \vec{r}_f - \vec{r}_i = 2\hat{x} - 2\hat{y} - 2\hat{z}$$

$$\hat{r} = \frac{\vec{r}}{|\vec{r}|}$$

$$\vec{F} = q\vec{E} = q \frac{Q}{4\pi\epsilon_0} \frac{1}{r^2} \hat{r}$$

Calculus

$$\vec{E} = \frac{kQ}{r^2}\hat{r} \qquad k = \frac{1}{4\pi\epsilon_0}$$



$$dq = \rho\, dV = \rho(x', y', z')\, \underbrace{dx'dy'dz'}_{d\tau'}$$

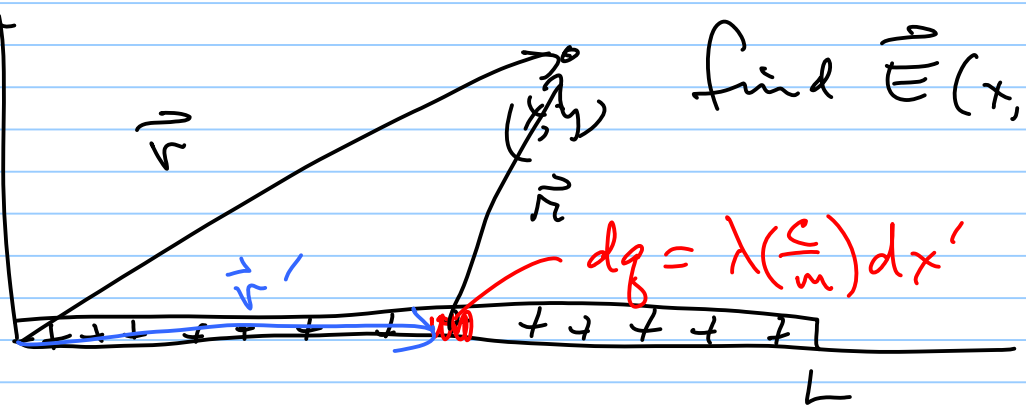
$$\vec{E} = \int d\vec{E} =$$

$$\vec{E}(x,y,z) = \int \frac{k\, dq}{r^2}\hat{r} = \iiint k\, \frac{\rho(x',y',z')dx'dy'dz'}{|\vec{r}(x,y,z) - \vec{r}(x',y',z')|^2}\hat{r}$$

Example:

$\hat{y}' = \hat{y}$

$\hat{x}' = \hat{x}$



find $\vec{E}(x, y)$

Principle: Coulomb's Law use superposition

Method:

$$d\vec{E} = k\frac{dq}{r^2}\hat{r}$$

find dq, $\vec{r}$: $dq = \lambda dx'$

$$\vec{r} = \vec{r} - \vec{r}' = x\hat{x} + y\hat{y} - x'\hat{x} = (x-x')\hat{x} + y\hat{y}$$

$$|\vec{r}| = \sqrt{(x-x')^2 + y^2}$$

$$\hat{r} = \frac{(x-x')\hat{x} + y\hat{y}}{\sqrt{(x-x')^2 + y^2}}$$

$$\vec{E}(x,y) = \frac{1}{4\pi\epsilon_0}\int_0^L \frac{\lambda\, dx'}{\left[(x-x')^2 + y^2\right]} \frac{(x-x')\hat{x} + y\hat{y}}{\sqrt{(x-x')^2 + y^2}}$$

Check answer - far from line of charge E should look like field from a point charge

- near in middle field should look like field from an ∞ line of charge