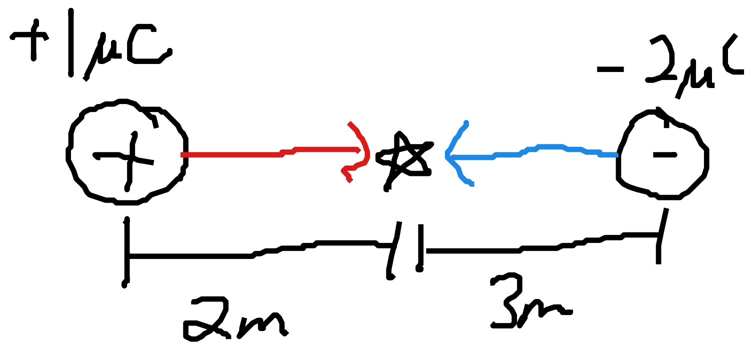
For multiple sources, $\vec{E}$ fields add together as vectors



What is $\vec{E}$ at star?

$$\vec{E}_{pt} = k\frac{q_s}{d^2}\hat{d}$$

$$\vec{E}_+ = (9\times10^9)\frac{(10^{-6})}{(2)^2} \rightarrow$$

$$= 2.25\times10^3\ \frac{N}{C} \rightarrow$$

$$\vec{E}_- = (9\times10^9)\frac{(-2\times10^{-6})}{(3)^2} \leftarrow$$

$$= 2\times10^3\ \frac{N}{C}\ (-\leftarrow)$$

$$= 2\times10^3\ \frac{N}{C} \rightarrow$$

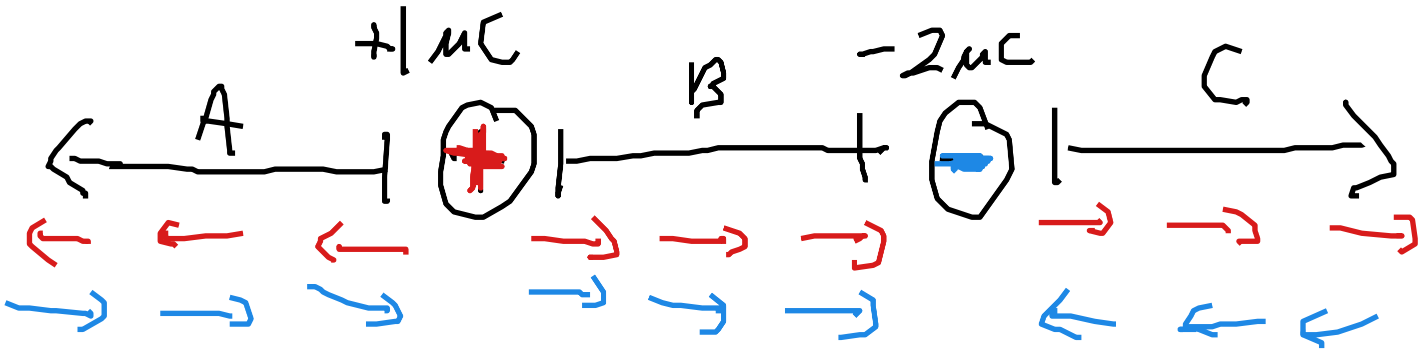
$$\vec{E}_{net} = \vec{E}_+ + \vec{E}_-$$

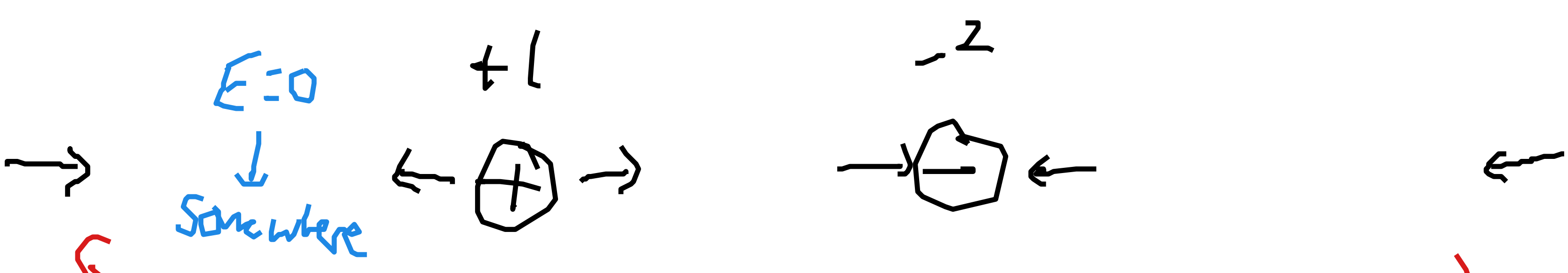
$k =$ " $\times 10^3$ "

$$= 2.25\ \frac{kN}{C} \rightarrow + 2\ \frac{kN}{C} \rightarrow$$

$$= 4.25\ \frac{kN}{C} \rightarrow$$

$$= 4250\ \frac{N}{C} \rightarrow$$

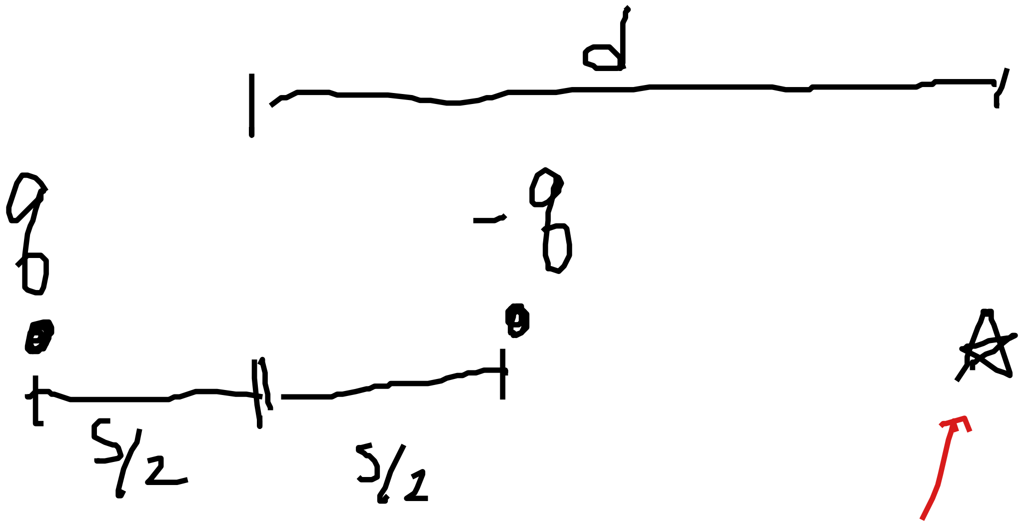




Far from system, field looks like field of a point charge

$+1\mu C - 2\mu C = -1\mu C$

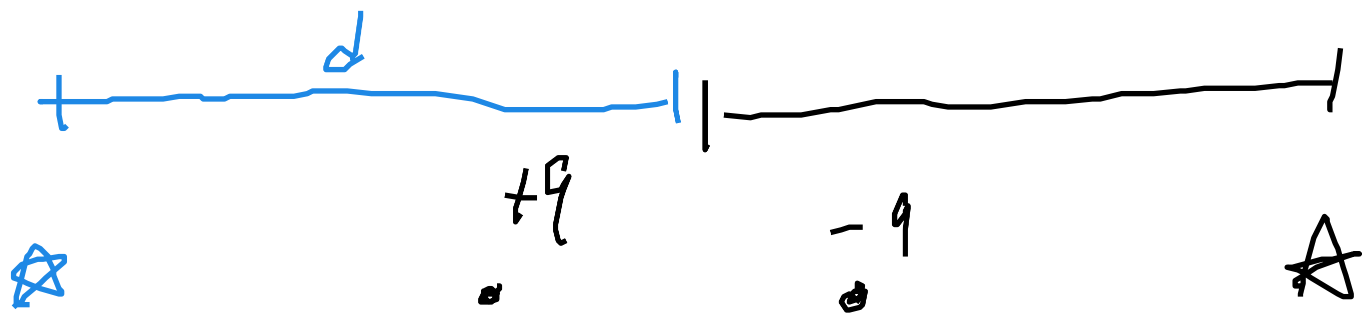
Dipole



If put charge q_T here,

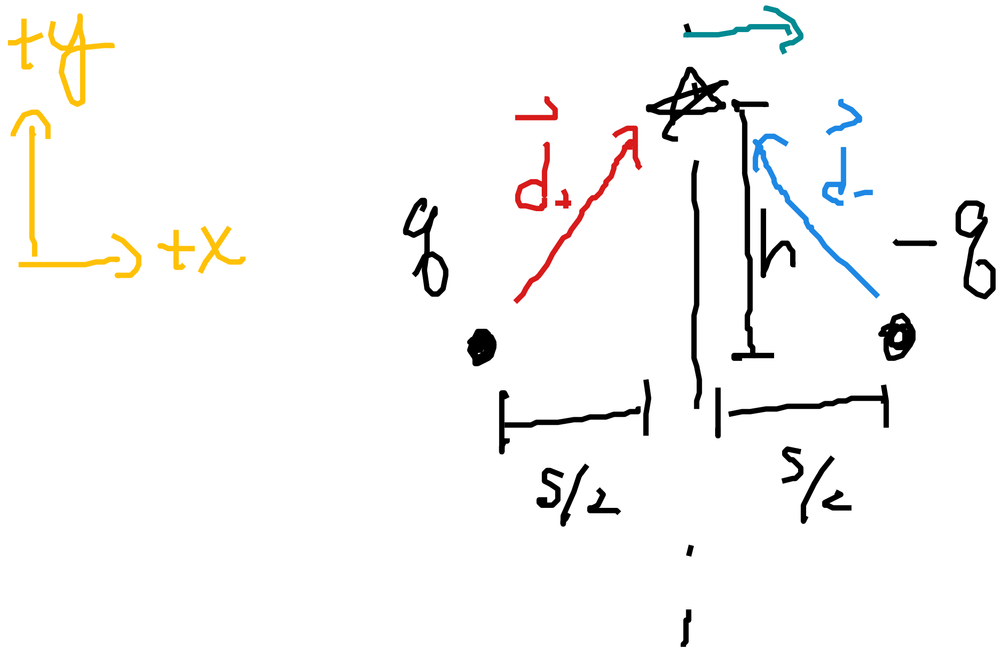
$$\vec{F} = k q_T \frac{2qs}{d^3} \leftarrow$$

$$\vec{E} = \frac{\vec{F}}{q_T} = k \frac{2qs}{d^3} \leftarrow$$



$k \frac{2qs}{d^3} \leftarrow$

$k \frac{2qs}{d^3} \leftarrow$



$$\vec{E} = k\frac{q_s}{d^3}\vec{d}$$

$$\vec{d}_+ = +\frac{s}{2}\hat{x} + h\hat{y} \qquad d = \sqrt{\left(\frac{s}{2}\right)^2 + h^2}$$

$$\vec{E}_+ = k\frac{q}{\left[\left(\frac{s}{2}\right)^2 + h^2\right]^{3/2}}\left[+\frac{s}{2}\hat{x} + h\hat{y}\right]$$

$$\vec{d}_- = -\frac{s}{2}\hat{x} + h\hat{y} \qquad d_- = \sqrt{\left(-\frac{s}{2}\right)^2 + h^2}$$

$$\vec{E}_- = k\frac{-q}{\left[\left(\frac{s}{2}\right)^2 + h^2\right]^{3/2}}\left[-\frac{s}{2}\hat{x} + h\hat{y}\right]$$

$$= k\frac{q}{\left[\left(\frac{s}{2}\right)^2 + h^2\right]^{3/2}}\left[+\frac{s}{2}\hat{x} - h\hat{y}\right]$$

$$\vec{E}_{net} = \vec{E}_+ + \vec{E}_-$$

$$= k\frac{q}{\left[\left(\frac{s}{2}\right)^2 + h^2\right]^{3/2}}\left[\left(+\frac{s}{2}\hat{x} + \cancel{h\hat{y}}\right) + \left(+\frac{s}{2}\hat{x} - \cancel{h\hat{y}}\right)\right]$$

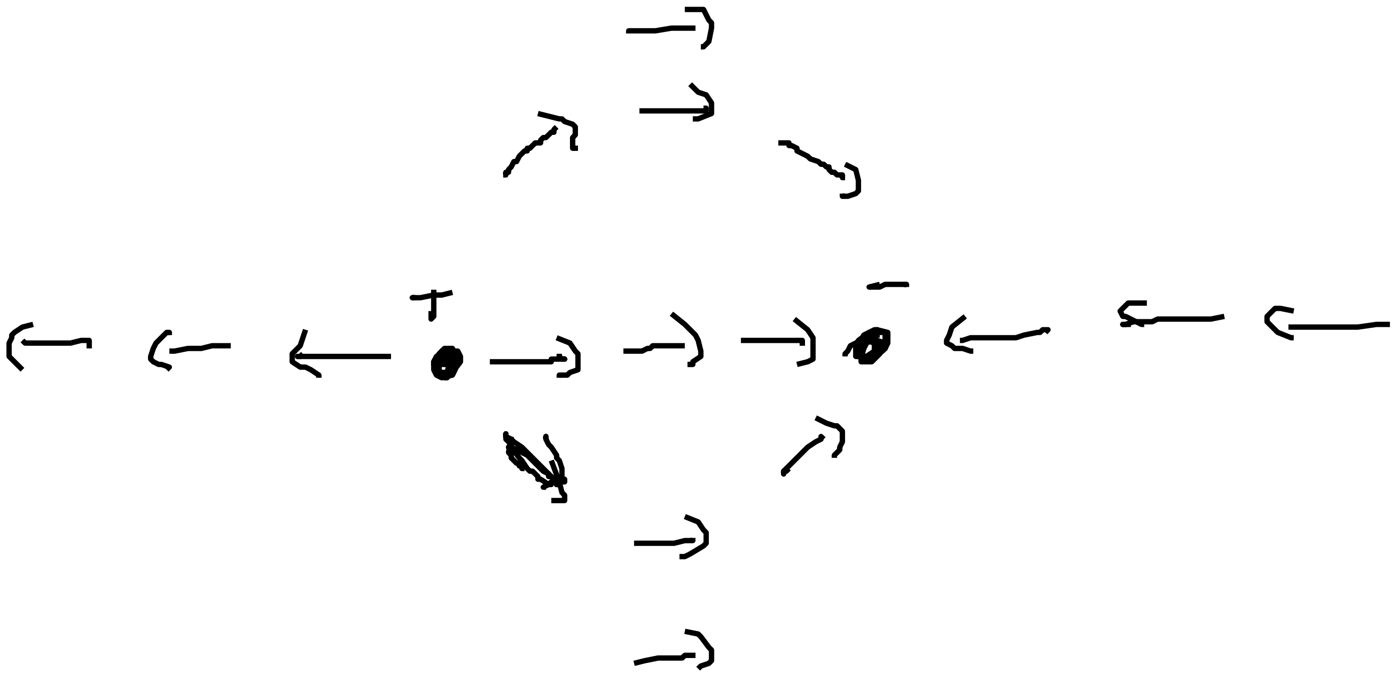
$$\vec{E}_{net} = kq\frac{s}{\left[\left(\frac{s}{2}\right)^2 + h^2\right]^{3/2}}\hat{x}$$

if $h >> s$, $\left(\frac{s}{2}\right)^2 + h^2 \approx h^2$

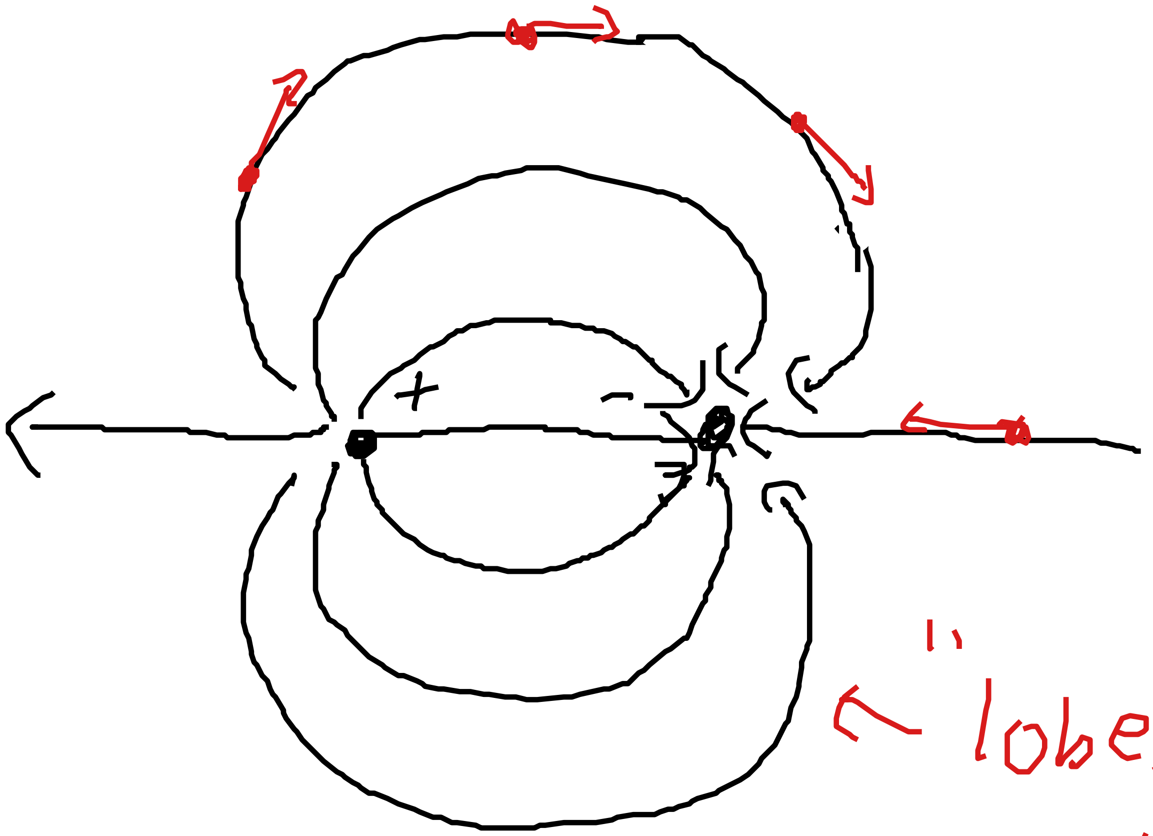
$$\vec{E}_{net} \approx kq\frac{s}{\left[h^2\right]^{3/2}}\hat{x}$$

$$\approx k\frac{qs}{h^3}\hat{x}$$

Field dies away as $\frac{1}{(\text{distance})^3}$, signature of dipole field (in all directions)



Electric Field Lines



"lobes" characteristic of dipole field

$\vec{E}$ is tangent to field line at all points