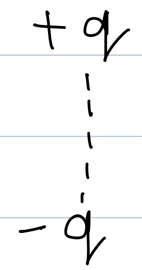
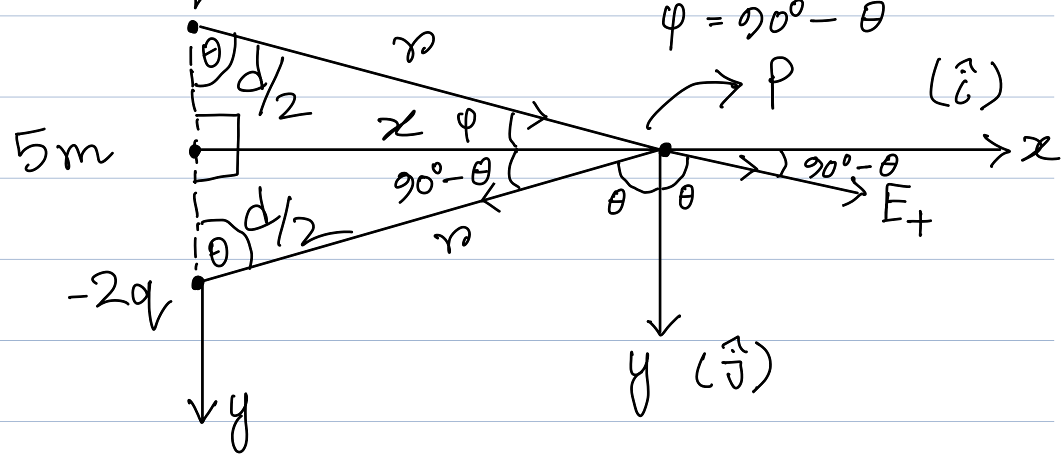
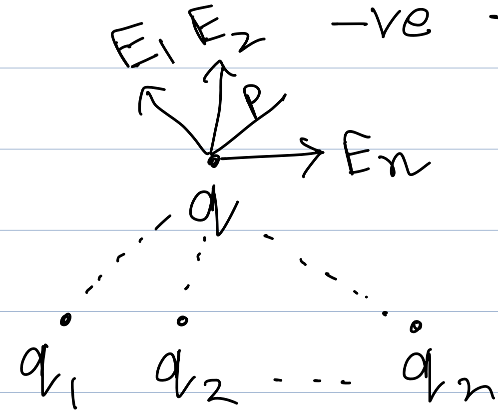
dipole system



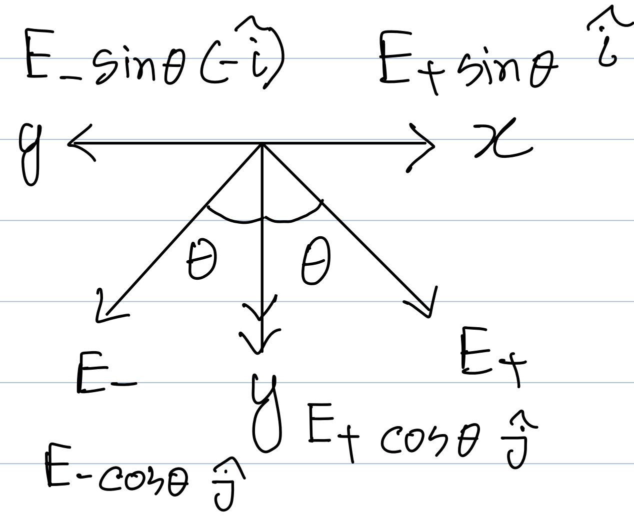
$$90^\circ + \theta + \varphi = 180^\circ$$
$$\varphi = 90^\circ - \theta$$



$P = |q|\vec{d}$ direction from -ve to +ve



$$\vec{E} = \vec{E_1} + \vec{E_2} + \dots + \vec{E_n}$$



$$E_+ = \frac{1}{4\pi\epsilon_0}\frac{|q|}{r^2} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$$

$$E_- = \frac{1}{4\pi\epsilon_0}\frac{|-q|}{r^2} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$$

$$E = E_+ = E_-$$

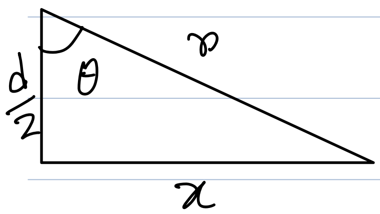
$$\vec{E}_{total} = \vec{E_+} + \vec{E_-}$$

$$= E_+\cos\theta\,\hat{j} + E_+\sin\theta\,\hat{i} + E_-\cos\theta\,\hat{j} + E_-\sin\theta\,(-\hat{i})$$

$$= E\cos\theta\,\hat{j} + E\sin\theta\,\hat{j} + E\cos\theta\,\hat{j} - E\sin\theta\,\hat{i}$$

$$= 2E\cos\theta\,\hat{j}$$

$$\cos\theta = \frac{d/2}{r} = \frac{d}{2r}$$



$$r^2 = \left(\frac{d}{2}\right)^2 + x^2$$

$$r = \sqrt{\left(\frac{d}{2}\right)^2 + x^2}$$

$$= \frac{2}{4\pi\epsilon_0} \frac{q}{r^2} \frac{d}{2r} \hat{j}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{qd}{r^3} \hat{j}$$

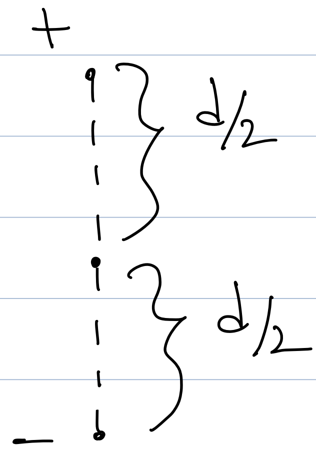
$$= \frac{1}{4\pi\epsilon_0} \frac{p}{r^3} \hat{j}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{p \hat{j}}{\left(x^2 + \left(\frac{d}{2}\right)^2\right)^{3/2}}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{p \hat{j}}{\left(x^2\left(1 + \frac{(d/2)^2}{x^2}\right)\right)^{3/2}}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{p}{(x^2)^{3/2}} \hat{j}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{p}{x^3} \hat{j}$$



$$= \frac{1}{4\pi\epsilon_0} \frac{p}{\left(\left(\frac{d}{2}\right)^2\right)^{3/2}} \hat{j}$$

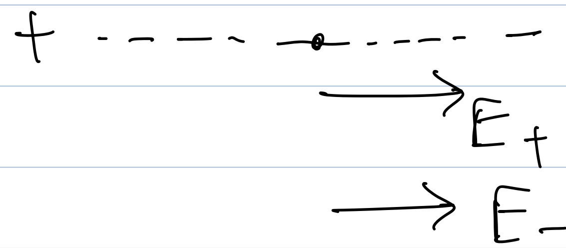
$$= \frac{1}{4\pi\epsilon_0} \frac{qd}{\left(\frac{d}{2}\right)^3} \hat{j}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{qd}{(d/2)^2 \frac{d}{2}}$$

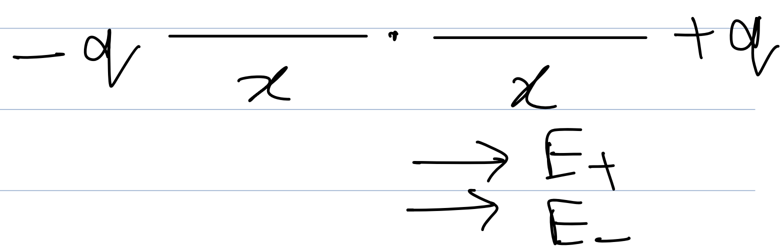
$$= 2 \cdot \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{\left(\frac{d}{2}\right)^2}$$

$= 2E$

$d = 6m$



$E = 2E$



$$2 \cdot \frac{1}{4\pi\epsilon_0} \frac{q}{x^2}$$

$F = qE$

$$E = E_+ \hat{i} + E_- \hat{i}$$
$$= 2E\hat{i}$$

$l \rightarrow q$

$1m \rightarrow \frac{q}{l} = \lambda \rightarrow$ Linear density

$A \rightarrow q$

$1m^2 \rightarrow \frac{q}{A} = \sigma \rightarrow$ Surface density

$V \rightarrow q$

$1m^3 \rightarrow \frac{q}{V} = \rho \rightarrow$ Volume density

$\lambda = f(x)$ Non uniform density

$\lambda =$ constant/ uniform