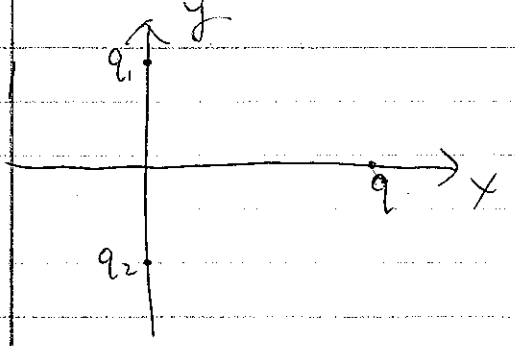
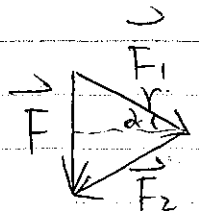
HW#4 Solution

21.71





$\sin\alpha = \frac{1.5}{2}$

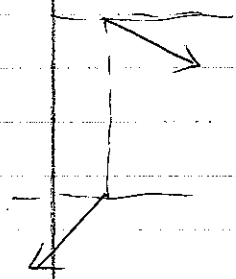
$\vec{F} = \vec{F_1} + \vec{F_2}$ $\quad |\vec{F_1}| = |\vec{F_2}| = k\left|\frac{q_1 q}{r^2}\right|$

$|\vec{F}| = 2|\vec{F_1}|\sin\alpha$

$= 2 \times 1.124 \times 10^{3}\ N \times 0.75$

$= 1686\ N$

along y axis in the negative direction.

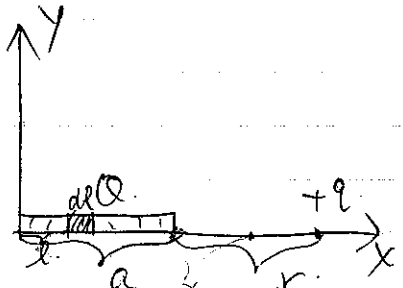


$T = F \cdot r \cdot \cos 2 \times 2$

$= 1.124 \times 10^{3} \times 1.5 \times 10^{-2} \times 0.6614 \times 2$

$= 22.3\ N\cdot m$ clockwise.

21.89



$dq = \frac{Q}{a} \cdot dl$

$x > a$.

(a) $dE = \frac{dq}{4\pi\varepsilon_0}\frac{1}{(x-l)^2}$

$E_x = \int_0^a \frac{Q}{4\pi\varepsilon_0 a}\frac{dl}{(x-l)^2} = \frac{Q}{4\pi\varepsilon_0 a}\frac{1}{x-l}\Big|_0^a = \frac{Q}{4\pi\varepsilon_0 a}\left(\frac{1}{x-a} - \frac{1}{x}\right)\vec{i}$

$\vec{E_y} = 0\vec{j}$

(b) +q locates at the point where $x = r + a$.

$\vec{E_x} = \frac{Q}{4\pi\varepsilon_0 a}\left(\frac{1}{r} - \frac{1}{r+a}\right)\vec{i}$

$\vec{F_x} = \frac{qQ}{4\pi\varepsilon_0 a}\left(\frac{1}{r} - \frac{1}{r+a}\right)\vec{i}$

(c) $|\vec{F_x}| = \frac{qQ}{4\pi\varepsilon_0 a}\frac{a}{r^2 + ar} = \frac{qQ}{4\pi\varepsilon_0 ar^2}\frac{a}{1+\frac{a}{r}}$ when $a \ll r$

$\frac{a}{r} \approx 0$

$|\vec{F_x}| \approx \frac{qQ}{4\pi\varepsilon_0 r^2}$ its field is the same as that of a point charge when +q is far from the line charge.