1.1)

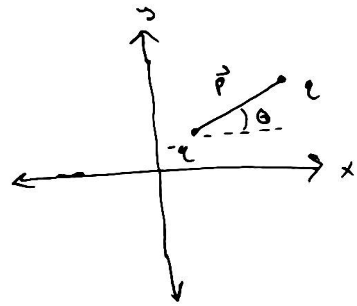
$\vec{p} = q\vec{d}$ $\quad$ $\vec{\tau} = \vec{r} \times \vec{F} = \vec{r}\sin\theta \vec{F}$

$E = E_0 \hat{x}$ $\quad$ $\vec{\tau} = \vec{p} \cdot E_0 \sin\theta$

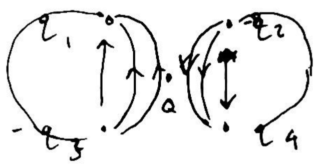
$\vec{\tau} = \vec{p} \times \vec{E}$

$F_{+q} = E_0 q+$ $\quad$ $\vec{E} = \frac{\vec{F}}{q}$

$F_{-q} = E_0 q-$ $\quad$ $\vec{F} = \vec{E} q$



1.2)



$E = \frac{1}{4\pi\varepsilon_0}$

2.1 a) $E_z = \frac{1}{4\pi\varepsilon_0}\int_0^L \frac{\lambda dx}{r^2}\cos\theta$ $\quad$ $E_x = -\frac{1}{4\pi\varepsilon_0}\int_0^L \frac{\lambda dx}{r^2}\sin\theta$

$= \frac{1}{4\pi\varepsilon_0}\lambda z\int_0^L \frac{1}{(z^2+x^2)^{3/2}}dx$ $\quad$ $= -\frac{1}{4\pi\varepsilon_0}\lambda\int_0^L \frac{x\,dx}{(x^2+z^2)^{3/2}}$

$= \frac{1}{4\pi\varepsilon_0}\frac{\lambda}{z}\frac{L}{\sqrt{z^2+L^2}}$ $\quad$ $= -\frac{1}{4\pi\varepsilon_0}\lambda\left[\frac{1}{z} - \frac{1}{\sqrt{z^2+L^2}}\right]$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{\lambda}{z}\left[\left(-1+\frac{z}{\sqrt{z^2+L^2}}\right)\hat{x} + \left(\frac{L}{\sqrt{z^2+L^2}}\right)\hat{z}\right]$$

b) $\oint \vec{E}\, dA = \frac{Q}{\varepsilon_0}$ $\quad$ $Q_c = \lambda dx$

$E\oint dA = \frac{Q}{\varepsilon_0}$ $\quad$ $E_T = \int_0^L \frac{\lambda dx}{4\pi\varepsilon_0 r^2}$

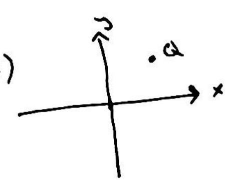
$E\, 4\pi r^2 = \frac{Q_i}{\varepsilon_0}$ $\quad$ $\Downarrow$

leads to answer from

$E = \frac{Q_i}{\varepsilon_0 4\pi r^2}$ $\quad$ a $\quad$ $E = \frac{1}{4\pi\varepsilon_0}\frac{\lambda}{z}\left[\left(-1+\frac{z}{\sqrt{z^2+L^2}}\right)\hat{x} + \left(\frac{L}{\sqrt{z^2+L^2}}\right)\hat{z}\right]$

2.2 $\quad E = \frac{\sigma}{2\varepsilon_0}$

a) $E = \frac{\sigma_1 - \sigma_2}{\varepsilon_0}$ $\quad$ b) $E = \frac{\sigma_1 + \sigma_2}{2\varepsilon_0}$ $\quad$ c)



$E = \frac{\sigma_x z}{2\varepsilon_0}\hat{x} + \frac{\sigma_y z}{2\varepsilon_0}\hat{y}$

3.1 $\oint \vec{E}\cdot d\vec{l} = 0$ $\quad$ $E = -\nabla V$ $\quad$ $-\int_A^B \vec{E}\cdot d\hat{l} = V(b) - V(a)$

$-\int_a^b -\nabla V\, d\vec{l} = \int_a^b V'\, dl = V(b) - V(a)$

$V(\vec{r}) = -\int_\infty^r E(r)\, dr'$ $\quad$ $E = k\frac{q}{r^2}\hat{r}$

$V(r) = -\int_\infty^r \left(\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\right)d\vec{r} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}\Big|_\infty^r = k\frac{q}{r}$