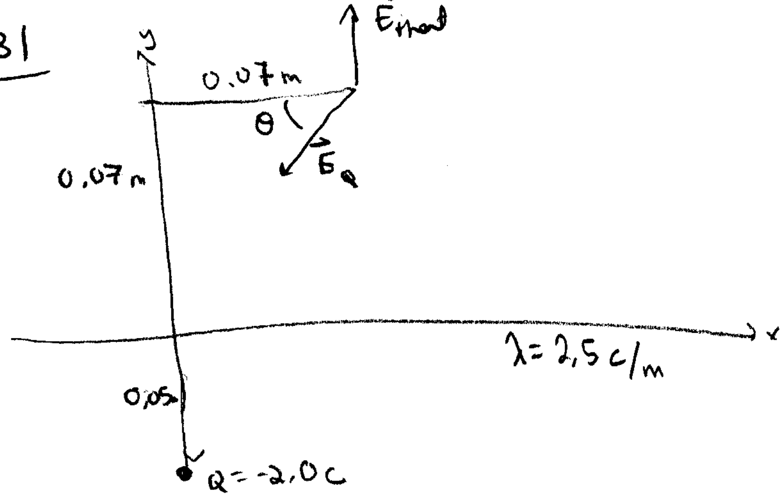
HW #2

21-26 $\vec{F} = (3.0\hat{i} - 3.9\hat{j})\times 10^{-3}\,N$

$\vec{F} = q\vec{E}$, so $\vec{E} = \frac{\vec{F}}{q} = \frac{(3.0\,\hat{i} - 3.9\,\hat{j})\times 10^{-3}\,N}{1.25\,\mu C}$

$$\boxed{\vec{E} = (2.4\,\hat{i} - 3.12\,\hat{j})\times 10^{3}\,N/C}$$

21-31



I want to find $\vec{E}_{total} = \vec{E}_{thread} + \vec{E}_Q$

As found in class, $E_{thread} = \frac{2k\lambda}{y}\hat{j}$, $y = 0.07\,m$

the field from the thread has both x and y components:

$E_x = E_Q\cos\theta \quad E_y = E_Q\sin\theta$

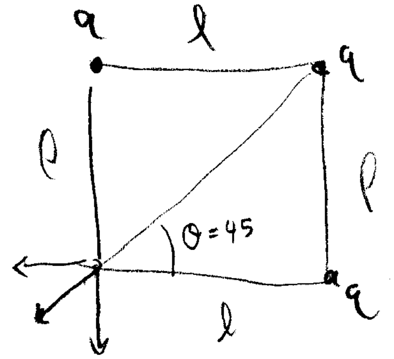
$E_Q = \frac{kQ}{\underbrace{[(0.07m + 0.05m)^2 + (0.07m)^2]}_{\text{call this } d}}$ and $\cos\theta = \frac{0.07m}{\sqrt{d}}$ $\sin\theta = \frac{0.12}{\sqrt{d}}$

So $E_{thread} = -\frac{kQ(0.07m)}{d^{3/2}}\hat{i} - \frac{kQ}{d^{3/2}}(0.12m)\hat{j}$

Adding:

$$\boxed{\vec{E}_{total} = \frac{-kQ(0.07m)}{d^{3/2}}\hat{i} + \left(\frac{2k\lambda}{0.07m} - \frac{kQ}{d^{3/2}}(0.12m)\right)\hat{j} = -4.699\times10^{11}\,N/C\,\hat{i} - 1.62\times10^{11}\,N/C\,\hat{j}}$$

21-33

$l = 1.22\,m$

$q = 2.25\,\mu C$

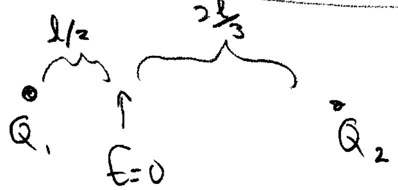
$\sin 45 = \frac{1}{\sqrt{2}} = \cos 45$

$$\vec{E} = k\left(\frac{q}{l^2}(-\hat{j}) + \frac{q}{l^2}(-\hat{i}) + \frac{q}{\sqrt{2}\underbrace{(l^2+l^2)}_{2l^2}}(-\hat{j}-\hat{i})\right)$$

$$= -\frac{kq}{l^2}\left[\left(1+\frac{1}{2\sqrt{2}}\right)\hat{j} + \left(1+\frac{1}{2\sqrt{2}}\right)\hat{i}\right]$$

$$\boxed{\begin{aligned}\vec{E} &= -1.84\times10^4\,N/c\,(\hat{i}+\hat{j}) \\ |E| &= (E_x^2+E_y^2)^{1/2} = 2.6\times10^4\,N/c\end{aligned}}$$

21-41



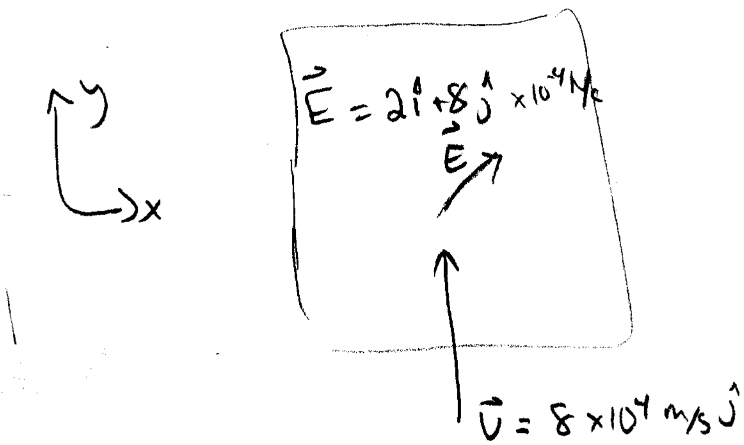
Use princ. of superposition: add fields and set equal to zero:

$$\cancel{k}\frac{Q_1}{(\cancel{l}/_{\cancel{2}})^2} - \frac{\cancel{k}Q_2}{(2\cancel{l}/\cancel{3})^2} = 0$$

$$Q_1 - \frac{Q_2}{4} = 0$$

$$Q_1 = \frac{Q_2}{4} \Rightarrow \boxed{\frac{Q_1}{Q_2} = \frac{1}{4}\ ,\ \frac{Q_2}{Q_1} = 4}$$

21-57



electron: $q = -e = 1.6\times10^{-19}$ C
$m = m_e = 9.11\times10^{-31}$ kg

a) $\vec{F} = m\vec{a} = q\vec{E}$

solve: $\vec{a} = \dfrac{q\vec{E}}{m} = \dfrac{-e}{m_e}\left(2\hat{i} + 8\hat{j} \times 10^{4}\,\text{N/C}\right)$

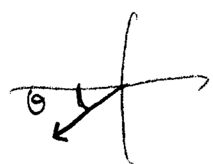
$= \left(-3.513\times10^{15}\hat{i} - 1.405\times10^{16}\hat{j}\right)\text{m/s}^2$

b) $\vec{v} = \vec{v}_i + \vec{a}t \qquad t = 1\times10^{-9}\,\text{s}$

$= 8\times10^{4}\,\text{m/s}\,\hat{j} + \left(-3.513\times10^{6}\hat{i} - 1.405\times10^{7}\hat{j}\right)\text{m/s}$

$\vec{v} = -3.5\times10^{6}\,\text{m/s}\,\hat{i} - 1.397\times10^{7}\,\text{m/s}\,\hat{j}$
$= v_x\hat{i} + v_y\hat{j}$

$\tan\theta = \dfrac{v_y}{v_x}$, so $\theta = 75.9°$



so $\phi = \underline{166°}$, measured relative to the initial direction counterclockwise