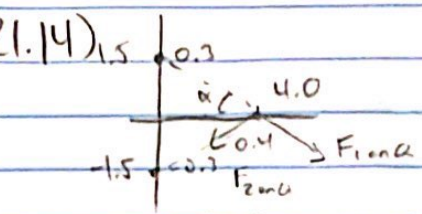
Physics 1B HW#5

21.14)



a) $|F| = \left(\frac{1}{4\pi\varepsilon_0}\cdot\frac{|q_1 q|}{r^2}\right) + \left(\frac{1}{4\pi\varepsilon_0}\cdot\frac{|q_2 q|}{r^2}\right)$

$|F| = \frac{Q}{4\pi\varepsilon_0 r^2}(|q_1| + |q_2|)$

$|F| = \frac{4.0\mu C}{4\pi\varepsilon_0 r^2}(3.0\mu C)(10^{-6})^2$

$|F_{1\text{on}2}| = |F_{2\text{on}1}|$

$|F_{1\text{on}2}| = \frac{1}{4\pi\varepsilon_0}\cdot\frac{|q_1 q|}{r^2}$

$= 0.216N$

$(F_{1\text{on}2})_x = |F_{1\text{on}2}|\cos\alpha = 0.1728N$

$(F_{1\text{on}2})_y = -0.1296N$

$(F_{2\text{on}1})_x = |F_{2\text{on}1}|\cos\alpha = -0.1728N$

$(F_{2\text{on}1})_y = -0.1296N$

$\boxed{|F| = 0.2592N}$

b) straight down

$\boxed{90° \text{ clockwise}}$

21.27) $v_0 = 1.10\times10^6 \frac{m}{s}$

$\vec{E} = \frac{F}{q_0}$

a) $v_x = 1.10\times10^6 \frac{m}{s}$

$x = 2.00cm$

$y = 0.5cm$

$a_y = ?$

$2cm = vt$

$t = 1.82\times10^{-8}s$

$y = \frac{1}{2}a_y t^2$

$a_y = 3.025\times10^{15}\frac{cm}{s^2}$

$= 3.025\times10^{13}\frac{m}{s^2}$

$F = ma = (9.11\times10^{-31}kg)(a_y)$

$F = 2.72\times10^{-17}N$

$\boxed{|\vec{E}| \frac{F}{q_0} = 172.24 N/C}$

b) $|\vec{E}| = \frac{F}{q_0}$

$F = 2.76\times10^{-17}N$

$F = mA$

mass is ↑ A↓

$\boxed{\text{no it misses}}$

c) $2.76\times10^{-17}N = mA$

$A = 1.65\times10^{10}\frac{m}{s^2}$

$\Delta Y = \frac{1}{2}(1.65\times10^{10}\frac{m}{s^2})(1.82\times10^{-8}s)^2$

$\boxed{\Delta Y = 2.731\times10^{-6}m}$

d) With the Electric field

$\boxed{\text{downward}}$

21.28) $V_0 = 1.00\times10^6\frac{m}{s}$

$y: 0.005m$

$x = 0.02m$

$a_y = ?\ V_y = ?$

$t = ?$

$0.02m = v_0 t$

$t = 2\times10^{-8}s$

$V_y^2 = V_0^2 + 2a(\Delta y)$

$0.005m = \frac{1}{2}(a_y)t^2$

$a_y = 2.5\times10^{13}\frac{m}{s^2}$

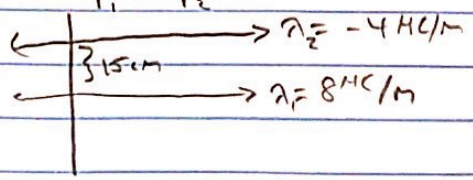
$V_y^2 = 2(a_y)(0.005)$

$V_y = 500000\frac{m}{s}$

$V_{tot} = 1118033.99\frac{m}{s}$

21.33) $E = \frac{\lambda}{2\pi\varepsilon_0 r}$

$\frac{n_1}{r_1} = \frac{n_2}{r_2}$



$r_1 = y \quad r_2 = y - 15cm$

$\frac{8nC/m}{y} = \frac{-4nC/m}{y-0.15m}$

$8nCy - 1.2nC = -4nCy$

$\boxed{y = 0.3m}$

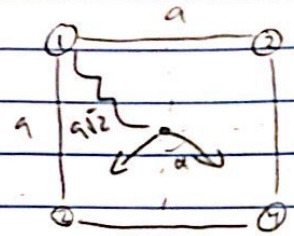
21.38) a) pos → neg

downward

b) $F = k\frac{|q_1|}{r^2}$

$r = a\sqrt{2}$

$r^2 = 2a^2$



$r = \frac{a}{2}\sqrt{2}$

$r^2 = \frac{1}{2}a^2$

$E = \frac{2kq}{a^2}$

$E_3 = \frac{2kq}{a^2}\left(\frac{\sqrt{2}}{2}\right) = \frac{\sqrt{2}kq}{a^2}$ → 4 forces

$E_{tot} = \frac{4\sqrt{2}kq}{a^2}$

21.50) $\lambda = 175\ nC/m$

a) $E = \frac{\lambda}{2\pi\varepsilon_0}\frac{L}{R\sqrt{L^2+4R^2}}$

$E = 3147.13\left(\frac{0.095m}{0.055m\sqrt{L^2+4R^2}}\right)$

$E = 37400.5\ N/C$

b) upward

c) $E = k\left(\frac{qx}{(x^2+a^2)^{3/2}}\right)$

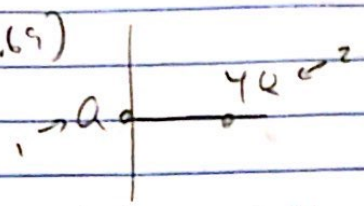
$= k\left(\frac{\frac{2\lambda L}{4\pi\varepsilon_0}}{(x^2+\frac{L^2}{4})^{3/2}}\right)$

$= 9\times10^9\ N/C\left(\frac{0.055m(175\times10^{-9}C)(0.095m)}{1.855\times10^{-4}}\right)$

$= 4.43\times10^4\ N/C$

d) upwards

21.69)



a) $k\frac{|q|}{x^2} = k\frac{|4q|}{(d-x)^2}$

$\frac{1}{x^2} = \frac{4}{(d-x)^2}$

$4x^2 = (d-x)^2$

$2 = \frac{(d-x)}{x}$

$2 = \frac{d}{x} - 1$

$d = 3x \rightarrow x = \frac{d}{3}$

b) negative

c) $k\frac{|2q|}{(d/3)^2} = k\frac{|4q_1|}{(d)^2}$

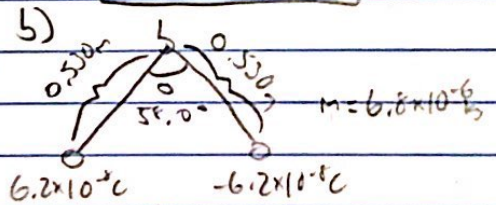
$\frac{2q}{d^2} = \frac{4q_1}{d^2}$

$q = -\frac{4Q}{9}$

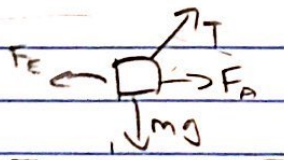
21.74) a) $\vec{F} \sim \vec{E}$

↳ one on the left

b)



$\vec{F} = 2_0\vec{E}$



$T_x = T\sin(29),\ T_y = T(\cos 29)$

$\Sigma F = ma$

$T\cos(29) - mg = 0$

$T = 7.63\times10^{-5}N$

$F_E = T\sin(29) + F_A$

$F_A = k\frac{|Q|^2}{d^2}$

$d = 2(0.530m)\sin 29^\circ = 0.514m$

$F_A = 1.58\times10^{-4}N$

$F_E = 1.95\times10^{-4}N$

$E = 2.86\times10^3\ N/C$

21,80) $dE_x = dE\cos\theta$

$E_x = \frac{Q}{4\pi\varepsilon_0 x} \cdot \frac{1}{\sqrt{x^2+a^2}}$

$\boxed{E_x = \frac{Qk}{x} \cdot \frac{1}{\sqrt{x^2+a^2}}}$

b) $dE_y = dE\sin\theta$

$E_y = \frac{Q}{4\pi\varepsilon_0 a}\left(\frac{1}{x} - \frac{1}{\sqrt{x^2+a^2}}\right)$

$\boxed{E_y = -\frac{Qk}{ax} + \frac{Qk}{a\sqrt{x^2+a^2}}}$

c) $\vec{F} = -q_0\vec{E}$

$\boxed{\vec{F} = \frac{-qQk}{x} \cdot \frac{1}{\sqrt{x^2+a^2}}}$

d) $\vec{F}_y = -q_0\vec{E}_y$

$\boxed{F_y = \frac{2qQk}{ax} - \frac{2qQk}{a\sqrt{x^2+a^2}}}$

21,87) a) $\sigma = \frac{Q}{A}$

$A = \pi R_2^2 - \pi R_1^2$

$\boxed{\pi\sigma(R_2^2 - R_1^2) = Q}$

b) $E_x = \int_0^{2\pi}\int_{r=R_1}^{r=R_2} \frac{\sigma k x r\,dr\,d\theta}{(x^2+r^2)} = \sigma k x \int_0^{2\pi}\left[\frac{1}{\sqrt{x^2+r^2}}\right]_{r=R_1}^{r=R_2} d\theta$

$\boxed{E_x = -2\pi\sigma k x\left(\frac{1}{\sqrt{x^2+R_2^2}} - \frac{1}{\sqrt{x^2+R_1^2}}\right)}$

c) $\boxed{\text{upward} \to +\infty,\ x}$

d) $F = -qE \quad F = -kx$

$\omega = \sqrt{\frac{k}{m}}$

$F = -2\pi\sigma k x q\left(\frac{1}{\sqrt{x^2+R_1^2}} - \frac{1}{\sqrt{x^2+R_2^2}}\right) = -kx$

$k = 2\pi\sigma k q\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\omega = \sqrt{\square}/m$

$\boxed{\omega = \sqrt{\frac{kq\sigma}{2\pi m}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}}$