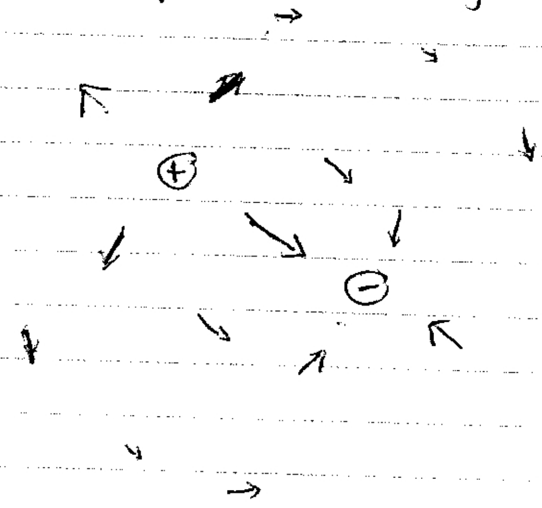
Phys 132 HW VI-VII

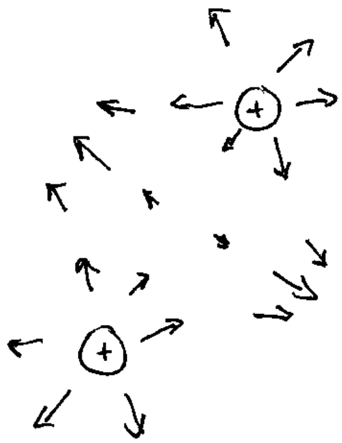
1) Sketch force on pos test charge at various locations

a)



Notice F is strong right in between charges

b)



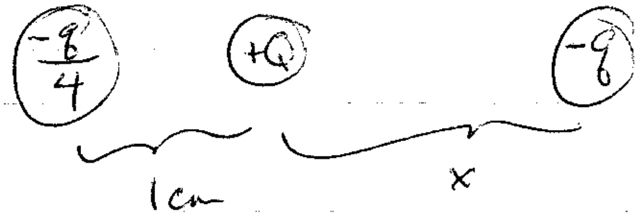
Notice F is weak right in between charges

2) $F = \frac{q_1 q_2}{4\pi\epsilon_0 r^2} = \frac{-10^{-3} \cdot 10^{-3}}{4\pi(8.85\times10^{-12})(.01)^2} N = \boxed{9\times10^{7} N}$

$m_{equiv} = \frac{F}{g} = \frac{9\times10^{7} N}{10 m/s^2} = \boxed{9\times10^{6} kg}$ Really big!

These forces are manageable because capacitors involve very large areas, so pressure on separating (insulating) material is negligible. In class, we saw forces between nano coulombs of charge.

3)

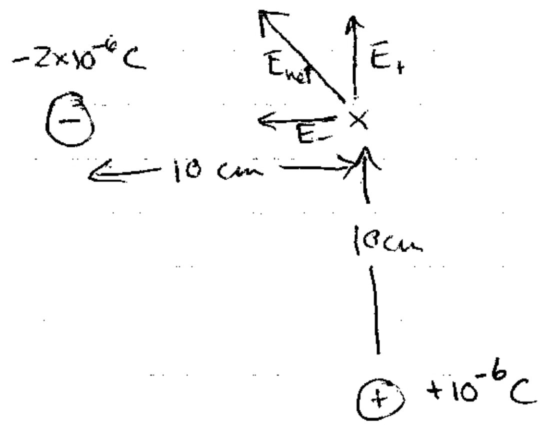


$$F=0, \text{ so } \frac{-qQ/4}{4\pi\epsilon_0(1cm)^2} = \frac{-qQ}{4\pi\epsilon_0(x)^2}$$

or $4\cdot(1cm)^2 = x^2$ (by inverting & canceling like terms)

$$X = \sqrt{4(1cm)^2} = \boxed{2cm}$$

4)



We must add $\vec{E}$'s as vectors — $\vec{E}$ from the + charge ($\vec{E}_+$) and $\vec{E}$ from the − charge ($\vec{E}_-$). This problem makes solution by components easy, since

$E_x = -|E_-|$ and $E_y = |E_+|$

$$\text{So } E_x = -\frac{q}{4\pi\epsilon_0(.1m)^2} = -\frac{2\times10^{-6}C}{4\pi(8.85\times10^{-12})(.1m)^2}$$

$-1.79\times10^6 N/C$

$$E_y = E_x = \frac{10^{-6}C}{4\pi(8.85\times10^{-12})(.1m)^2} = 9\times10^5\ N/C$$

5) $$F_{grav} = \frac{G m_1 m_2}{r^2} \qquad G = 6.67\times10^{-11}\ \frac{Nm^2}{kg^2}$$

$$F_{elec} = \frac{q_1 q_2}{4\pi\epsilon_0 r^2} \qquad \epsilon_0 = 8.85\times10^{-12}\ \frac{C^2}{Nm^2}$$

$$\frac{F_{elec}}{F_{grav}} = \left(\frac{q_1 q_2}{4\pi\epsilon_0 \cancel{r^2}}\right)\left(\frac{\cancel{r^2}}{G m_1 m_2}\right) = \left(\frac{q}{m}\right)^2\left(\frac{1}{4\pi\epsilon_0 G}\right)$$

if $q_1 = q_2$ & $m_1 = m_2$

Notice r's vanish, since both forces are $1/r^2$ dependency
For the proton, $m = 1.67\times10^{-27}kg$, $q = 1.6\times10^{-19}C$, so

$$\frac{F_{elec}}{F_{grav}} = \left(\frac{1.6\times10^{-19}C}{1.67\times10^{-27}kg}\right)^2 \frac{1}{4\pi(8.85\times10^{-12}\frac{C^2}{Nm^2})(6.67\times10^{-11}\frac{Nm^2}{kg^2})}$$

$$= 1.2\times10^{36} \Leftarrow \text{phenomenal!}$$

It is no surprise one can neglect gravitational effects in atoms & molecules!