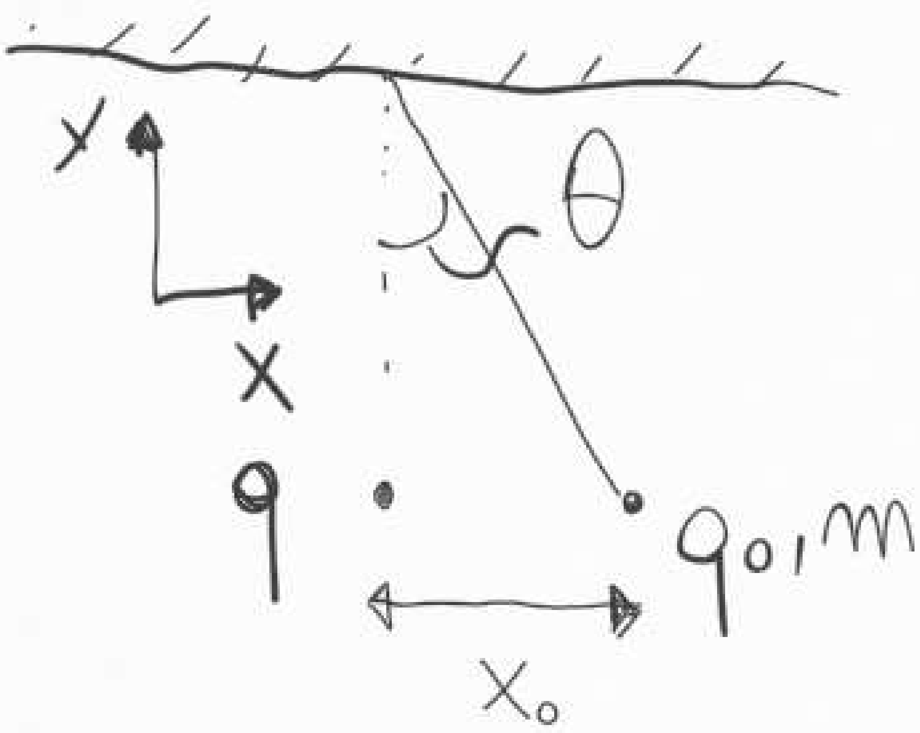
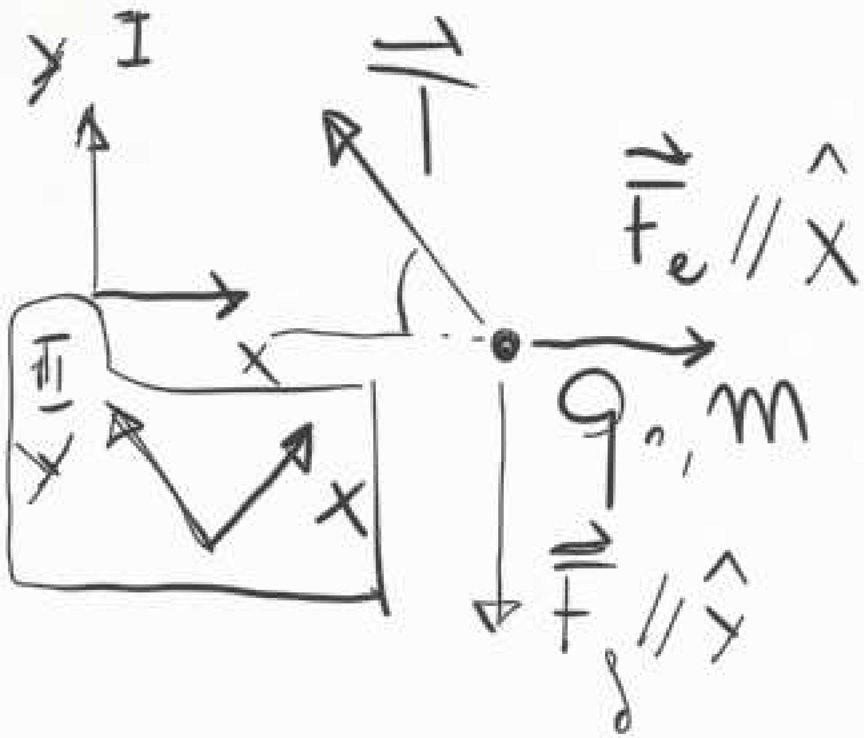


0) q, q_0

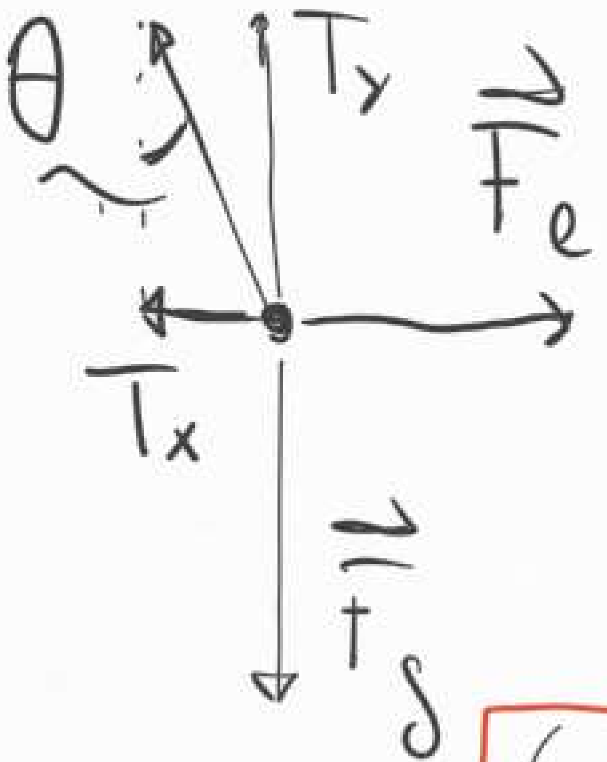
1) $\theta = \theta(x_0) = ?$

$$\boxed{\vec{F}_{TOT} = 0 = \vec{F}_g + \vec{F}_e + \vec{T}}$$



I

F_e



$$\vec{T} = (T_x, T_y)$$

$$T_x = T\sin\theta$$

$$T_y = T\cos\theta$$

$$\boxed{\begin{cases} F_e - T_x = 0 \\ -F_g + T_y = 0 \end{cases}}
\begin{array}{l} \Rightarrow F_e = T\sin\theta \Rightarrow T = \dfrac{F_e}{\sin\theta} \\ \Rightarrow F_g = T\cos\theta = \dfrac{F_e}{\sin\theta}\cos\theta \Rightarrow \end{array}$$

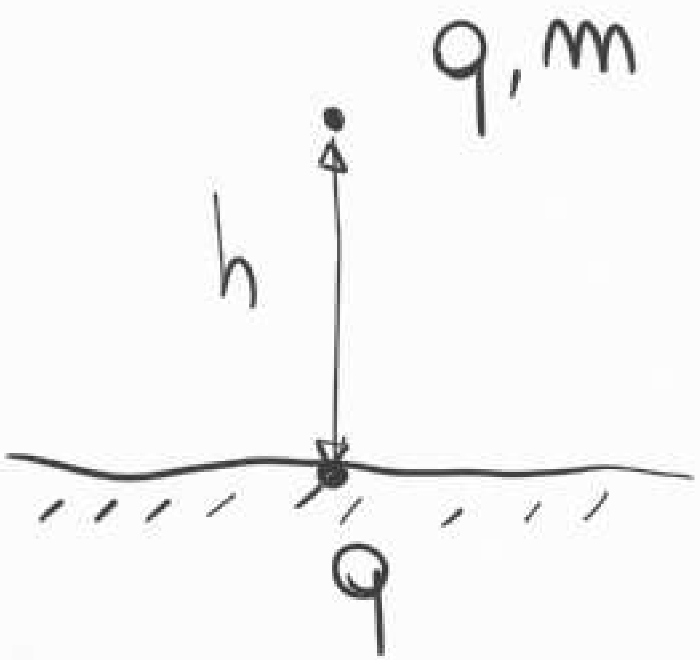
$$\frac{\sin\theta}{\cos\theta} = \tan\theta = \frac{F_e}{F_g} = \boxed{\frac{q q_0}{4\pi\varepsilon_0}\frac{1}{x_0^2 m g}}$$

$$T_x = T \sin\theta \quad , \quad \begin{cases} F_e = T_x = T \sin\theta \\ F_g = T_y = T \cos\theta \end{cases} \Rightarrow$$
$$T_y = T \cos\theta$$

$$\begin{cases} T = \dfrac{F_e}{\sin\theta} \\ F_g = T\cos\theta = \dfrac{F_e}{\sin\theta}\cos\theta \end{cases} \Rightarrow \boxed{\dfrac{\sin\theta}{\cos\theta} = \tan\theta = \dfrac{F_e}{F_g}}$$

2) $\theta = ?$

$m = 2 \cdot 10^{-3}\,kg$, $q_0 = 2 \cdot 10^{-9}\,C$, $q = 5 \cdot 10^{-7}\,C$, $x_0 = 5\,cm$



1) $m = m(q) : h$

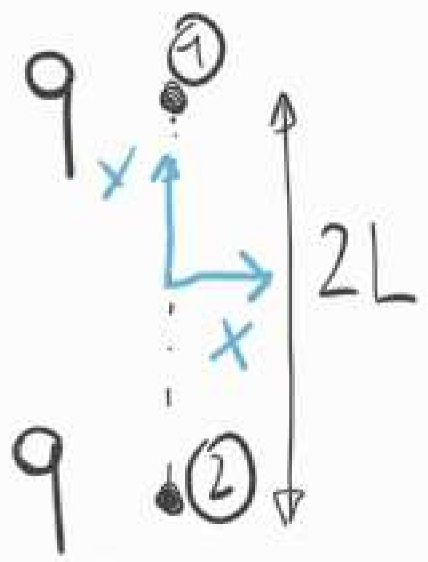
2) $q = ?$, $h = 10^{-2}\,m$, $m = 3 \cdot 10^{-3}\,g$

3) $n_e = ?$

$$F_e - F_g = 0, \quad \frac{q^2}{4\pi\varepsilon_0}\frac{1}{h^2} = mg \Rightarrow \frac{q^2}{m} = 4\pi\varepsilon_0 h^2 g$$

$$q = \pm\sqrt{4\pi\varepsilon_0 h^2 m g} = \pm 5.72 \cdot 10^{-10}\,C$$

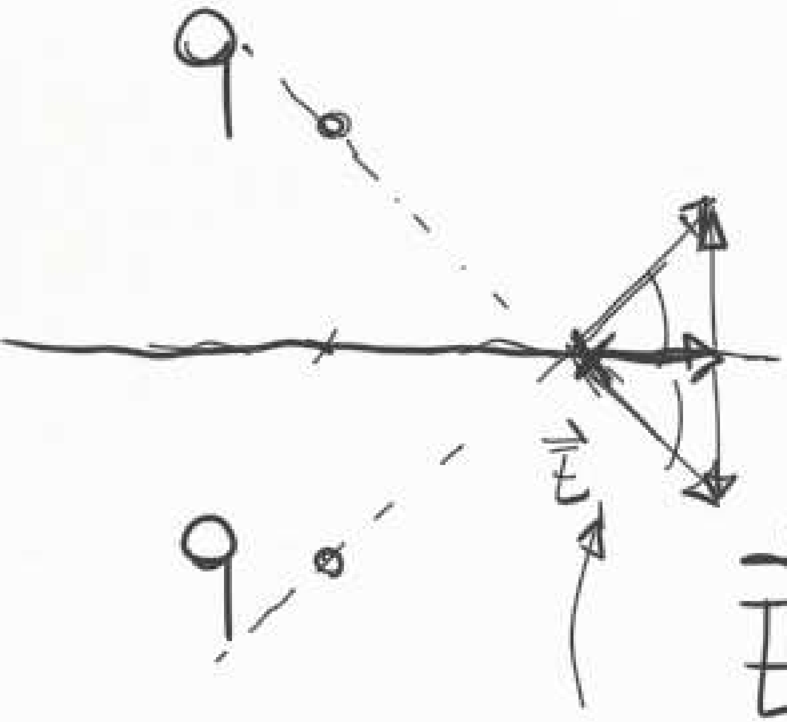
$$n_e = \frac{|q|}{e}$$



$$\vec{E} = \vec{E}(x_0) = ?, \quad q > 0$$

$$\boxed{\vec{E} = \frac{q}{4\pi\varepsilon_0} \frac{\hat{r}}{r^2}}$$

$$\vec{r}_1 = (0, L), \quad \vec{r}_2 = (0, -L), \quad \vec{r}_0 = (x_0, 0)$$



$$\vec{r}_{01} = \vec{r}_0 - \vec{r}_1 = (x_0, -L), \quad r_{01} = \sqrt{x_0^2 + L^2} = r_{02}$$

$$\hat{r}_{01} = \frac{1}{r_{01}} (x_0, -L)$$

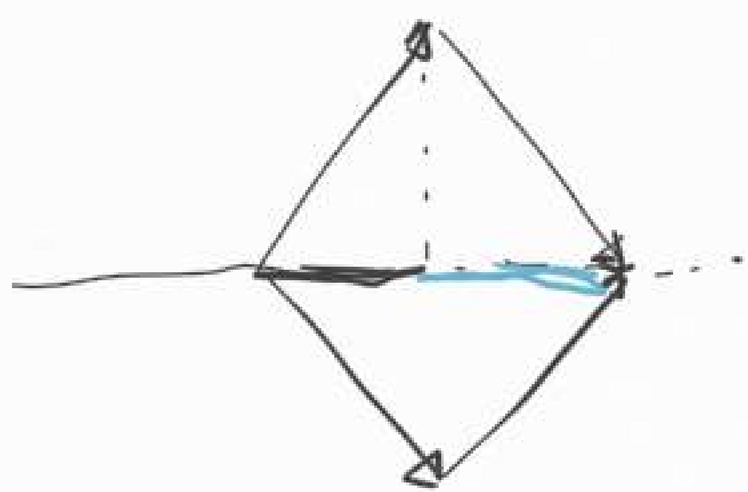
$$\vec{E}_1 = \frac{q}{4\pi\varepsilon_0} \frac{1}{r_{01}^2} \frac{(x_0, -L)}{r_{01}} = \frac{q}{4\pi\varepsilon_0} \frac{1}{r_{01}^3} (x_0, -L)$$

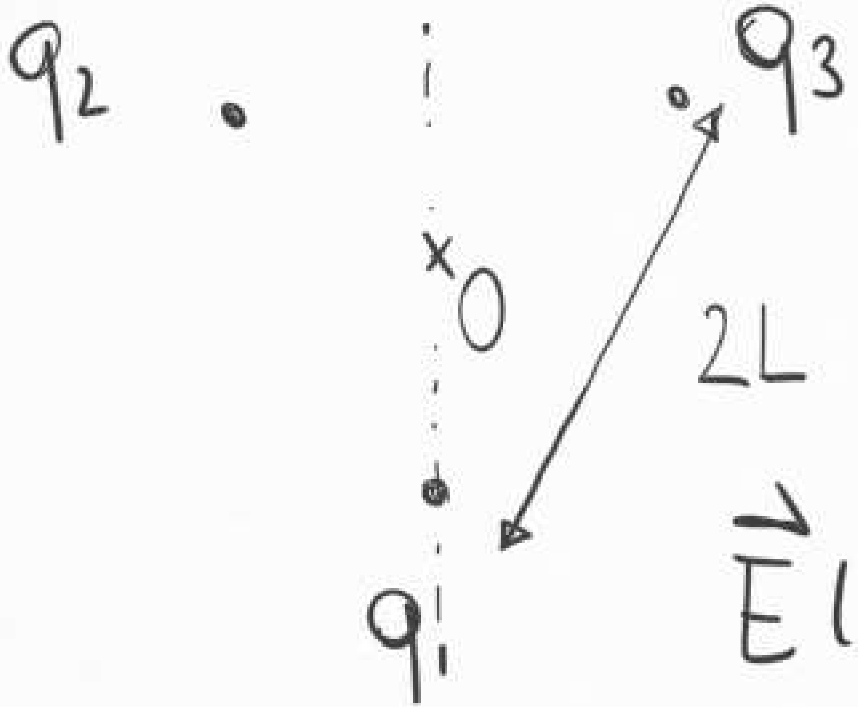
$$\vec{r}_{02} = \vec{r}_0 - \vec{r}_2 = (x_0, L), \quad r_{02} = \sqrt{x_0^2 + L^2}, \quad \hat{r}_{02} = \frac{1}{r_{02}}(x_0, L)$$

$$\vec{E}_2 = \frac{q}{4\pi\varepsilon_0}\frac{1}{r_{02}^3}(x_0, L), \qquad \vec{E}_1 = a\,(x_0, -L)$$

$$\vec{E}_2 = a\,(x_0, L)$$

$$\boxed{\vec{E} = \vec{E}_1 + \vec{E}_2 = \frac{q}{4\pi\varepsilon_0}\frac{1}{r_{01}^3}(2x_0, 0)},$$



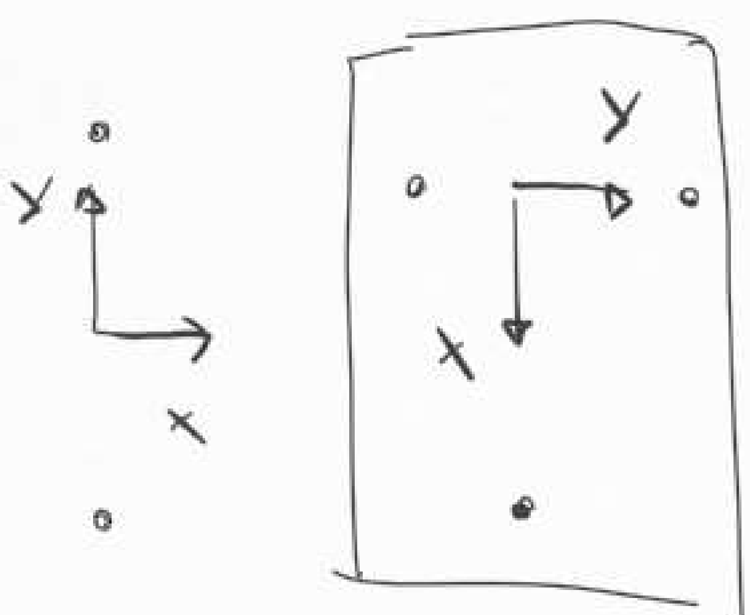


$2L$ 1) $\vec{E}(\vec{O}) = ?$

$q_2 = q_3 = q$

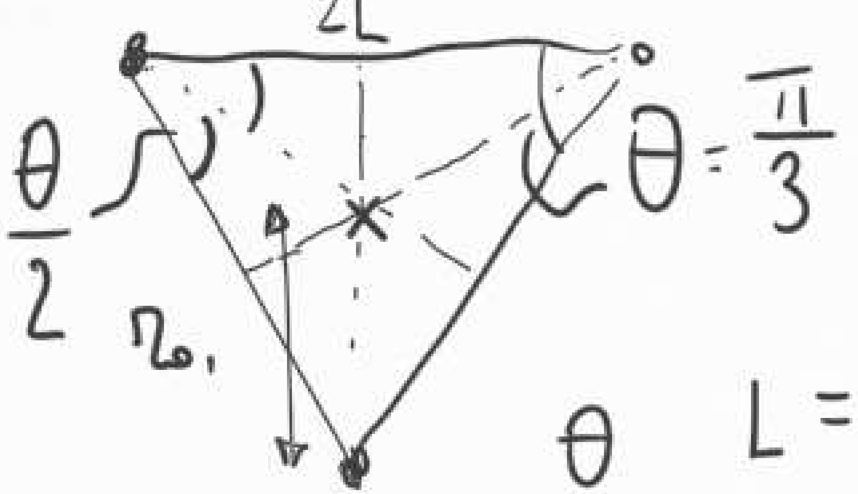
$$\vec{E}(O) = \vec{E}_1(\vec{O}) + \vec{E}_2(\vec{O}) + \vec{E}_3(\vec{O}) =$$

$$= \vec{E} + (\vec{E}_2 + \vec{E}_3)$$



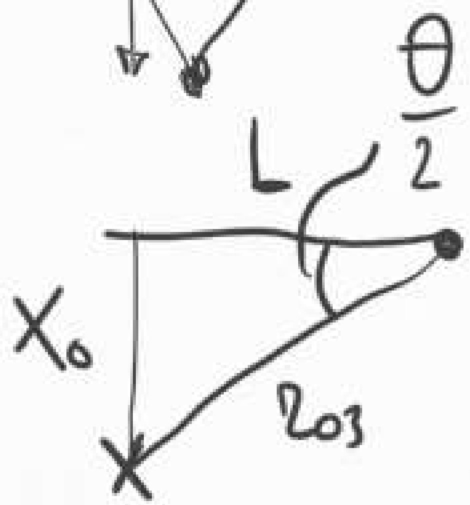
$$E_2 + \bar{E}_3 = \frac{q}{4\pi\varepsilon_0}\,\frac{2x_0}{r_{02}^3}$$

$$E_1 = \frac{q_1}{4\pi\varepsilon_0}\,\frac{(-1)}{r_{01}^2}$$



$r_{01} = r_{02} = r_{03}$

$L = r_{03} \cos \frac{\theta}{2} \Rightarrow r_{03} = \frac{L}{\cos \frac{\theta}{2}} = \frac{L}{\cos \frac{\pi}{6}} = \frac{L}{\cos 30^0}$



$X_0 = r_{03} \sin \frac{\theta}{2}$

$\bar{E}_2 + \bar{E}_3 = \frac{q}{4\pi\varepsilon_0} \frac{2X_0}{r_{03}^3} = \boxed{\frac{q}{4\pi\varepsilon_0} \frac{1}{r_{03}^2}}$

$\vec{r}_{01} = \vec{r}_0 - \vec{r}_1 = (-r_{03}, 0)$, $\vec{r}_0 = (x_0, 0)$, $\vec{r}_1 = (x_0 + r_{01}, 0)$

$E_1 = \boxed{\frac{q_1}{4\pi\varepsilon_0} \frac{(-1)}{r_{01}^2}} \Rightarrow E = \bar{E}_1 + \bar{E}_2 + \bar{E}_3 = \frac{1}{4\pi\varepsilon_0} \frac{1}{r_{01}^2} (q - q_1)$

2) $q_2 \cdot \quad \vec{O} \times \quad \cdot q_3$, $q_1 = 2q$, $\vec{E}(\vec{O}) = 0$

$\updownarrow \cdot q_1$

DOVE DOBBIAMO METTERE q_1

AFFINCHÉ $\vec{E}(\vec{O}) = 0$