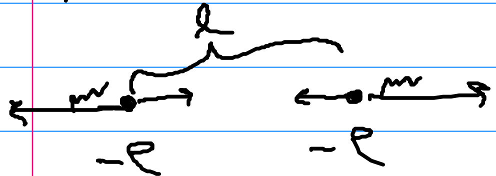
1.1.1 (Př. z el. a mag., Sedlák a spol.)



$e = 1.6 \times 10^{-19}\ C$

$\varepsilon_0 = 8.85 \times 10^{-12}\ F/m$

$\varkappa = 6.67 \times 10^{-11}\ m^3 kg^{-1} s^{-2}$

$m = ?$ $\qquad F_E = F_G$

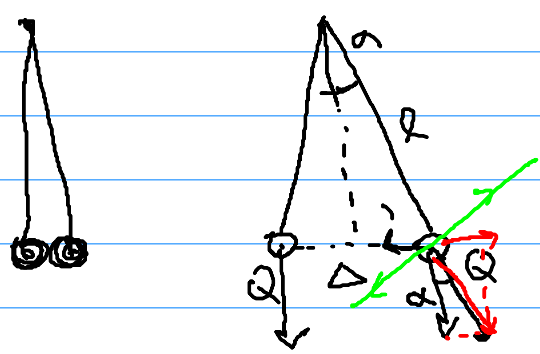
$m_p = 1.7 \times 10^{-27}\ kg$

$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{l^2} = \varkappa \frac{m^2}{l^2}$$

$$\rightarrow m = 1.9 \times 10^{-9}\ kg$$

$$\therefore 10^{18} \times m_p$$

1.1.5 MĚŘENÍ NÁBOJE



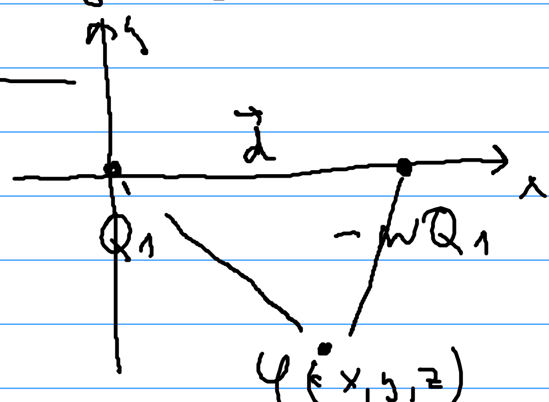
$\sin\alpha = \frac{\frac{\Delta}{2}}{l}$ $\qquad mg$

$F_g' = F_g \cdot \sin\alpha = F_g \frac{\Delta}{2l}$

$F_g' = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{\Delta^2}$

$m = 1g$ $\quad l = 1m$ $\quad \Delta = 5cm$ $\quad \rightarrow Q = 8.3 \times 10^{-9}\ C$

1.1.9



$\varphi(\vec{r}) = 0$

$$\left[\varphi = \frac{1}{4\pi\varepsilon_0}\sum_i \frac{q_i}{r_i}\right.$$

$$\varphi = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q_1}{\sqrt{x^2+y^2+z^2}} - \frac{nQ_1}{|\vec{r}-\vec{d}|}\right) = 0$$

$$\sqrt{(x-d)^2+y^2+z^2}$$

$$\frac{1}{\sqrt{x^2+y^2+z^2}} = \frac{m}{\sqrt{(x-d)^2+y^2+z^2}}$$

$$\sqrt{(x-d)^2+y^2+z^2} = m\sqrt{x^2+y^2+z^2}$$

$$(x-d)^2+y^2+z^2 = m^2\left(x^2+y^2+z^2\right)$$

$$\underbrace{x^2-2xd+d^2-m^2x^2} + y^2(1-m^2) + z^2(1-m^2) = 0$$

$$x^2(1-m^2) - 2xd + d^2 + \dots$$

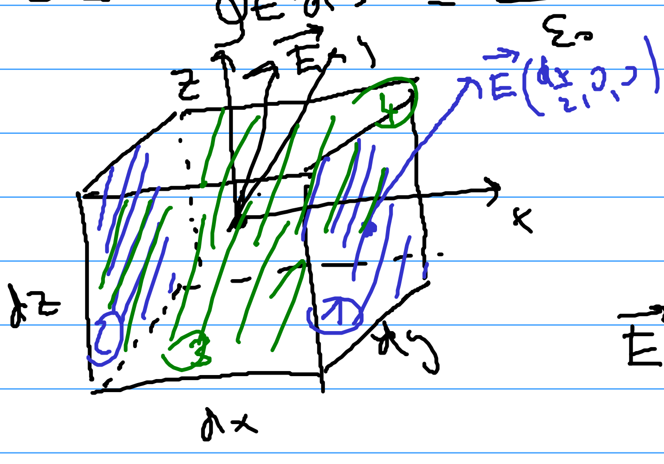
$$x^2 - \frac{2xd}{1-m^2} + \frac{d^2}{1-m^2} + y^2 + z^2 = 0$$

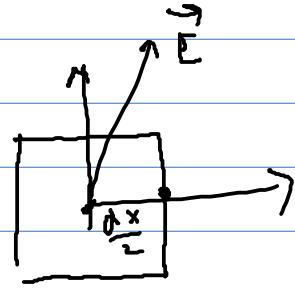
$$(x-a)^2 + y^2 + z^2 = R^2 \qquad S = (a,0,0) \quad R$$

$$a = \frac{d}{1-m^2} \qquad R = \frac{dm}{m^2-1}$$

$m \to 1$ $\quad q \mid -q \quad$ $a \to \infty \quad R \to \infty$

GZ $\oint \vec{E}\cdot d\vec{S} = \frac{Q_{in}}{\varepsilon_0}$





$$\vec{E}\left(\frac{dx}{2},0,0\right) = \vec{E}(0,0,0) + \frac{\partial \vec{E}}{\partial x}\cdot\frac{dx}{2}$$

$$\int_{S_1} = \int_{\square} \left(\vec{E}(0,0,0) + \frac{\partial \vec{E}}{\partial x}\frac{dx}{2}\right)\cdot(1,0,0)\, dy\, dz$$

$$= \int_{\square} \left(E_x(0) + \frac{\partial E_x}{\partial x}\frac{dx}{2}\right) dy\, dz =$$

$$= \left(E_x(0) + \frac{\partial E_x}{\partial x}\frac{dx}{2}\right) dy\, dz$$

$$S_2 = \int_{\square_2} \left(\vec{E}(0) - \frac{\partial \vec{E}}{\partial x}\frac{dx}{2}\right)\cdot(-1,0,0)\, dy\, dz$$

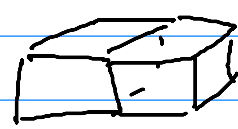
$$= \left(-E_x(0) + \frac{\partial E_x}{\partial x}\frac{dx}{2}\right)\cdot dy\, dz$$

$$S_1 + S_2 = \frac{\partial E_x}{\partial x}\cdot dx\, dy\, dz = \frac{\partial E_x}{\partial x}\, dV$$

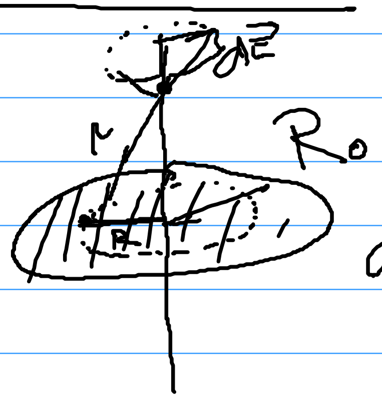
$$S_3 + S_4 = \frac{\partial E_y}{\partial y}\, dV$$

$$S_5 + S_6 = \frac{\partial E_z}{\partial z}\, dV$$

$$\oint_{\square} = \left(\frac{\partial E_x}{\partial x} + \frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z}\right) dV = \underline{\nabla\cdot\vec{E}}\, dV$$



$$\oint_S \vec{E}\cdot d\vec{S} = \int_V \nabla\cdot\vec{E}\, dV$$



1) $\vec{E}$ на оси

$$d\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{\sigma\,\vec{r}\,dS}{r^3}$$

$$\vec{E} = \int_{\square} d\vec{E}$$

$$E_z = \int_0^{2\pi}\int_0^{R_0} \frac{1}{4\pi\varepsilon_0}\frac{\sigma z}{(R^2+z^2)^{3/2}}\cdot R\, d\varphi \cdot dR$$

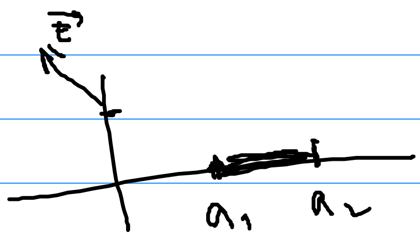
$$= \frac{2\pi\,\sigma z}{4\pi\varepsilon_0}\int_0^{R_0}\frac{R\,dR}{(R^2+z^2)^{3/2}} = \left[\begin{aligned} t &= R^2+z^2 \\ dt &= 2R\,dR \end{aligned}\right]$$

$$= \frac{\sigma z}{2\varepsilon_0}\int_{z^2}^{R^2+z^2}\frac{\frac{1}{2}\,dt}{t^{3/2}} =$$

$$= \frac{-\sigma z}{2\varepsilon_0}\left[t^{-\frac{1}{2}}\right]_{z^2}^{R^2+z^2} = -\frac{\sigma z}{2\varepsilon_0}\left(\frac{1}{\sqrt{R^2+z^2}}-\frac{1}{z}\right)$$

$$R\to\infty \qquad \boxed{E_z \to \frac{\sigma}{2\varepsilon_0}}$$

DÚ $\vec{E}$ NABITÉ ÚSEČKY $\longrightarrow$ NABITÉ PŘÍMCE



λ hustota náboje

$\downarrow$

GAUSSEM?