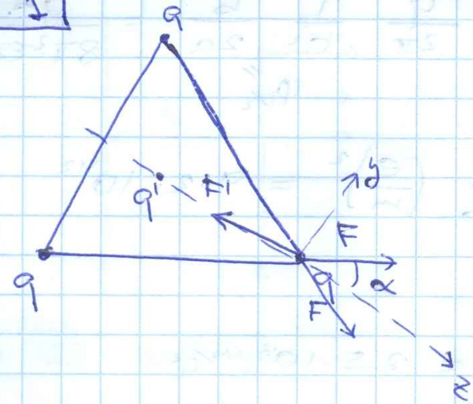
1.1 **1**



1) Заметим, каким бы ни был заряд q', сумма сил, действ. на него равна 0.

2) $R = \frac{2}{3} a \frac{\sqrt{3}}{2} = \frac{a\sqrt{3}}{3}$

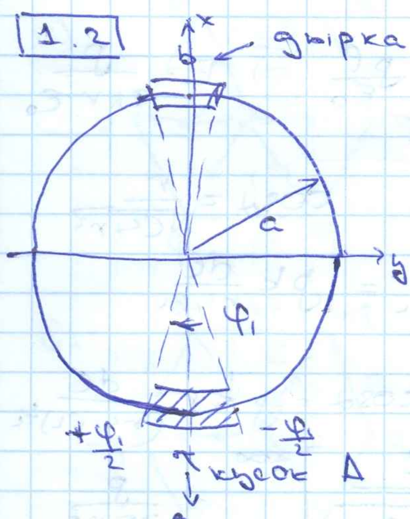
$$F = \frac{kq^2}{a^2}$$

$$F' = \frac{kqq'}{R^2} = \frac{3kqq'}{a^2}$$

$$\begin{cases} z: & F' + 2F\cos\alpha = 0 \\ y: & F\sin\alpha - F\sin\alpha = 0 \end{cases}$$

$$\frac{3kqq'}{a^2} + \frac{2kq^2}{a^2}\frac{\sqrt{3}}{2} = 0 \Rightarrow q' = -\frac{\sqrt{3}}{3} q$$

1.2



В силу симметрии, легко видеть, что напряжённость в центре кольце будет создаваться только куском A.

$$2\pi a - b = \left(2\pi - \frac{b}{a}\right) a = \varphi_0 a$$

$$\varphi_1 = \frac{b}{a} \qquad dq = \frac{q}{\varphi_0} d\varphi$$

$$dE = \frac{k\,dq}{a^2} = \frac{kq}{\varphi_0 a^2} d\varphi$$

$$dE_x = dE\cos\varphi \qquad dE_y = dE\sin\varphi$$

$$E_y = \int dE_y = \int_{-\varphi_1/2}^{\varphi_1/2} \frac{kq}{\varphi_0 a^2} \sin\varphi\, d\varphi = 0.$$

$$E_x = \int dE_x = \int_{-\varphi_1/2}^{\varphi_1/2} \frac{kq}{\varphi_0 a^2} \cos\varphi\, d\varphi = \frac{kq}{\varphi_0 a^2} \sin\varphi \Big|_{-\varphi_1/2}^{+\varphi_1/2} =$$

$$= \frac{2kq}{\varphi_0 a^2}\sin\frac{\varphi_1}{2} \approx 2\cdot\frac{1}{4\pi\varepsilon_0}\,\frac{q}{2\pi}\,\frac{1}{a^2}\,\underbrace{\frac{b}{2a}}_{\varphi_1/2} = \frac{qb}{8\pi^2\varepsilon_0 a^3}$$

$\boxed{1.3}$

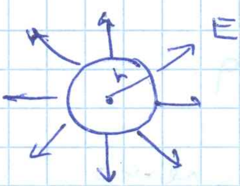
$$\frac{F_k}{F_r} = \frac{\frac{ke^2}{a^2}}{\frac{Gm_e^2}{a^2}} = \frac{1}{4\pi\varepsilon_0 G}\left(\frac{e}{m}\right)^2 = 4.2\cdot 10^{42}$$

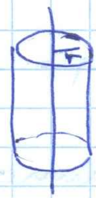
$\boxed{1.4}$

$$a = \frac{F_k}{m} = \frac{1}{4\pi\varepsilon_0}\,\frac{e^2}{ma^2} = 2.5\cdot 10^{8}\ м/с^2$$

$\boxed{1.5}$ 1) Выведем напряжённость электр. поля нити на расстоянии r.

способ 1: (т. Гаусса)





$$\Phi = 2\pi r l\cdot E$$

$$q = \rho l$$

$$2\pi r l\,E = \frac{\rho l}{\varepsilon_0} \Rightarrow E = \frac{\rho}{2\pi r\varepsilon_0}$$

способ 2:

$$dq = \rho\, dl \qquad \cos\alpha = \frac{r}{\sqrt{l^2+r^2}}$$

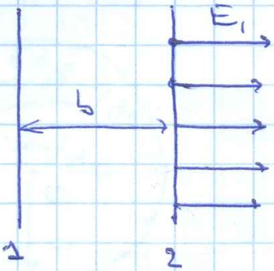
$$dE = \frac{k\,dq}{r^2+l^2} = \rho k\frac{dl}{r^2+l^2}$$

$$dE_z = dE\cos\alpha = \rho k r\frac{dl}{(r^2+l^2)^{3/2}}$$

$$E_z = \frac{\rho r}{4\pi\varepsilon_0}\int_{-\infty}^{+\infty}\frac{dl}{(r^2+l^2)^{3/2}} = \frac{\rho r}{4\pi\varepsilon_0}\left[\frac{l}{r^2\sqrt{l^2+r^2}}\right]_{-\infty}^{+\infty} = \frac{\rho}{2\pi r\varepsilon_0}$$

проекц. $E_x = 0$ в силу симметрии

г)

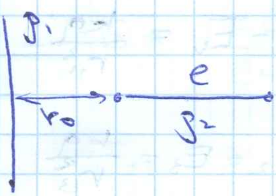


$$F = \rho l \cdot E_1$$

$$\frac{F}{l} = \frac{\rho^2}{2\pi b \varepsilon_0}$$

$\boxed{1.6}$ из задачи 1.5 имеем, что $E(l) = \frac{\rho_1}{2\pi l \varepsilon_0}$

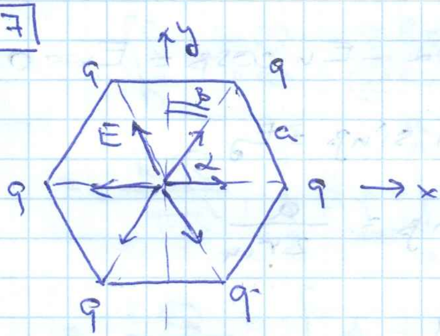
т.о.
$$F = \int E(l)\,dq = \int_{r_0}^{r_0+l} \frac{\rho_1}{2\pi l \varepsilon_0}\rho_2\,dl =$$



$$= \frac{\rho_1\rho_2}{2\pi\varepsilon_0}\ln l\Big|_{r_0}^{r_0+l} = \frac{\rho_1\rho_2}{2\pi\varepsilon_0}\ln\left(1+\frac{l}{r_0}\right).$$

$\boxed{1.7}$

а)



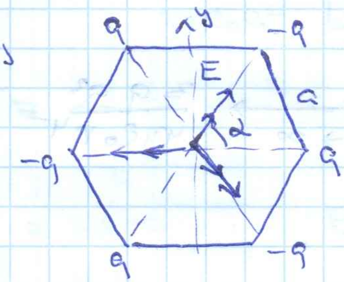
$$E = \frac{kq}{a^2}$$

x: $E + 2E\cos\alpha - 2E\cos\alpha - E = 0$

y: $2E\cos\beta - 2E\cos\beta = 0.$

$$E_\Sigma = 0.$$

б)



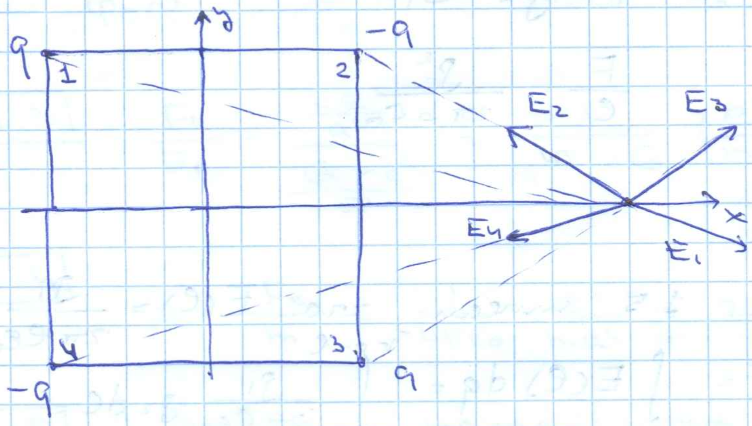
$$E = \frac{kq}{a^2}$$

x: $-2E + 4E\cos\alpha = 0$

y: $2E\sin\alpha - 2E\sin\alpha = 0.$

$$E_\Sigma = 0.$$

$\boxed{1.8}$



$$r_1 = r_4 = \sqrt{\frac{a^2}{4} + \left(\frac{a}{2} + x\right)^2} = r_{14} \qquad E_1 = E_4 = \frac{kq}{r_{14}^2}$$

$$r_2 = r_3 = \sqrt{\frac{a^2}{4} + \left(x - \frac{a}{2}\right)^2} = r_{23} \qquad E_2 = E_3 = \frac{kq}{r_{23}^2}$$

$$x: \quad E_1 \cos\beta + E_3 \cos\alpha - E_2 \cos\alpha - E_4 \cos\beta = E_x = 0$$

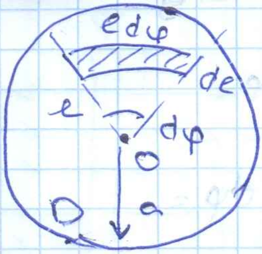
$$y: \quad (E_2 + E_3) \sin\alpha - (E_1 + E_4) \sin\beta = E_y$$

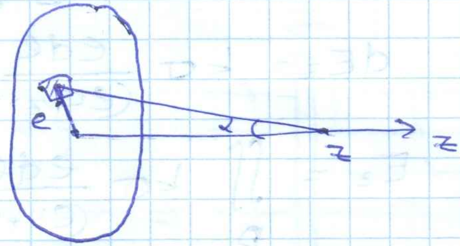
$$\sin\alpha = \frac{a}{2r_{23}} \qquad \sin\beta = \frac{a}{2r_{14}}$$

$$E_y = \frac{2kq}{r_{23}^2} \frac{a}{2r_{23}} - \frac{2kq}{r_{14}^2} \frac{a}{2r_{14}} =$$

$$= kqa \left(\frac{1}{r_{23}^3} - \frac{1}{r_{14}^3}\right) \xrightarrow[x \to \infty]{} \frac{3qa^2}{4\pi\varepsilon_0 r^4}$$

$\boxed{1.9}$





$$dq = \frac{Q}{\pi a^2}\,\rho\,d\varphi\,d\rho \qquad \cos\alpha = \frac{z}{\sqrt{z^2+\rho^2}}$$

$$dE = \frac{k\,dq}{\rho^2+z^2} = \frac{kQ}{\pi a^2}\,\frac{\rho\,d\rho}{\rho^2+z^2}\,d\varphi$$

$$dE_z = dE\cos\alpha = \frac{kQ}{\pi a^2}\,\frac{\rho\,d\rho}{(\rho^2+z^2)^{3/2}}\,d\varphi$$

$$E_z = \iint_D \frac{kQ}{\pi a^2}\,\frac{z\rho\,d\rho}{(\rho^2+z^2)^{3/2}}\,d\varphi =$$

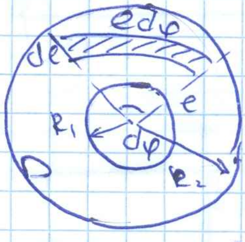
$$= \frac{kQ}{\pi a^2}\int_0^{2\pi} d\varphi \int_0^a \frac{z\rho\,d\rho}{(\rho^2+z^2)^{3/2}} = \frac{Q}{2\pi\varepsilon_0 a^2}\cdot\frac{z}{z}\left[-\frac{z}{\sqrt{\rho^2+z^2}}\right]$$

$$= \frac{Q}{2\pi\varepsilon_0 a^2}\left[1 - \frac{z}{\sqrt{a^2+z^2}}\right]$$

$$z \ll a: \qquad E_z = \frac{Q}{2\pi\varepsilon_0 a^2}$$

$$z \gg a: \qquad E_z = \frac{Q}{4\pi\varepsilon_0 z^2}$$

1.10 по аналогии с задачей 1.9



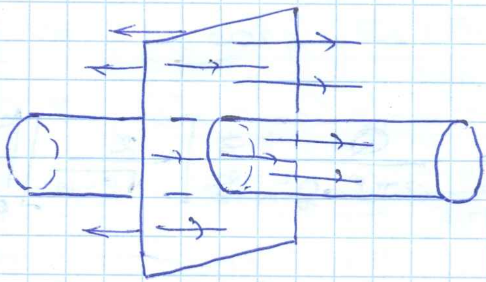
$$dE_z = k\sigma \frac{\rho\, d\rho}{(\rho^2+z^2)^{3/2}}\, z\, d\varphi$$

$$E_z = \iint_D k\sigma \frac{\rho\, d\rho}{(\rho^2+z^2)^{3/2}}\, z\, d\varphi =$$

$$= k\sigma \int_0^{2\pi} d\varphi \int_{R_1}^{R_2} \frac{z\rho\, d\rho}{(\rho^2+z^2)^{3/2}} =$$

$$= \frac{\sigma}{2\varepsilon_0}\left[-\frac{z}{\sqrt{\rho^2+z^2}}\right]_{R_1}^{R_2} = \frac{\sigma}{2\varepsilon_0}\left[\frac{z}{\sqrt{R_1^2+z^2}} - \frac{z}{\sqrt{R_2^2+z^2}}\right]$$

1.11 Способ 1: (т. Гаусса)

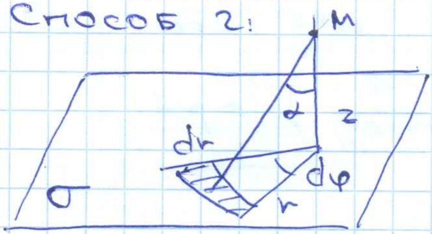


$$\Phi = 2SE$$

$$q = \sigma S$$

$$2SE = \frac{\sigma S}{\varepsilon_0} \rightarrow E = \frac{\sigma}{2\varepsilon_0}$$

Способ 2:



$$dq = \sigma r\, d\varphi\, dr$$

$$\cos\alpha = \frac{z}{\sqrt{z^2+r^2}}$$

$$dE = \frac{k\, dq}{r^2+z^2} = \sigma k \frac{r\, dr}{z^2+r^2}\, d\varphi$$

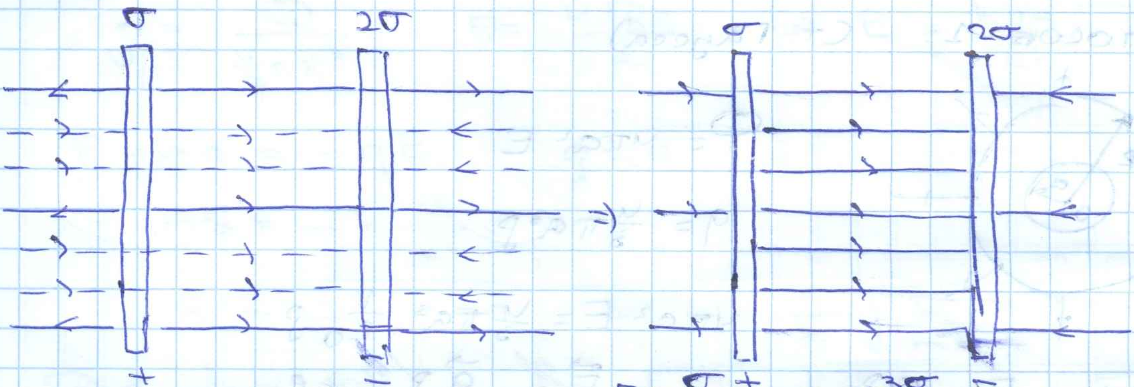
$$dE_z = dE\cos\alpha = \sigma k z \frac{r\, dr}{(z^2+r^2)^{3/2}}\, d\varphi$$

$$E_z = \sigma k \int_0^{2\pi} d\varphi \int_0^{\infty} \frac{r\, dr}{(z^2+r^2)^{3/2}}$$

$$E_z = \pi\sigma k \cdot z \int_0^{+\infty} \frac{dr^2}{(z^2+r^2)^{3/2}} = \pi\sigma k z \left[-\frac{2}{\sqrt{r^2+z^2}}\right]_0^{\infty} =$$

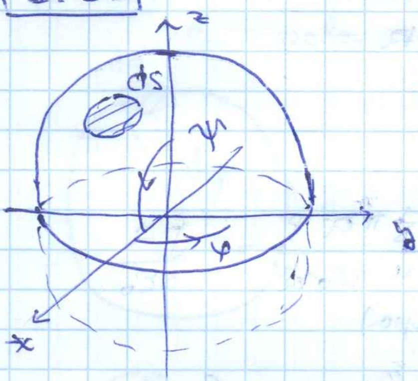
$$= \frac{\sigma}{2\varepsilon_0}$$

$\boxed{1.12}$



$E_1 = \frac{\sigma}{2\varepsilon_0}$ $E_2 = \frac{3\sigma}{2\varepsilon_0}$ $E_3 = \frac{\sigma}{2\varepsilon_0}$

$\boxed{1.13}$



$$dE = \frac{k\,dq}{R^2} = \frac{k\sigma}{R^2}\,ds$$

$$dE_z = \frac{k\sigma}{R^2}\cos\psi\,ds$$

$$dE_x = \frac{k\sigma}{R^2}\sin\psi\cos\varphi\,ds$$

$$dE_y = \frac{k\sigma}{R^2}\sin\psi\sin\varphi\,ds$$

$$E_z = \frac{k\sigma}{R^2}\iint_S \cos\psi\,dS = \frac{k\sigma}{R^2}\iint_S \cos\psi\,R^2\sin\psi\,d\varphi\,d\psi$$

$$= -k\sigma\int_0^{2\pi} d\varphi \int_0^{\pi/2}\cos\psi\,d\cos\psi = -\frac{2\pi\sigma}{4\pi\varepsilon_0}\cdot\frac{1}{2}\left[\cos^2\frac{\pi}{2} - \cos^2 0\right]$$

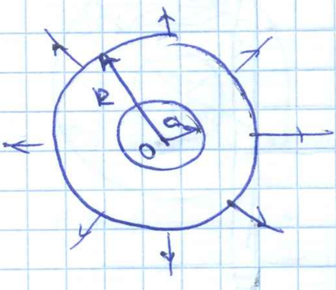
$$= \frac{\sigma}{4\varepsilon_0}$$

$$E_y = \iint_S dE_y = 0 \qquad E_x = \iint_S dE_x = 0.$$

$$\vec{E} = \vec{k}\,E_z, \qquad k = (0,0,1).$$

$\boxed{1.14}$ 1) Рассмотрим шар без полости:

способ 1. (т. Гаусса)



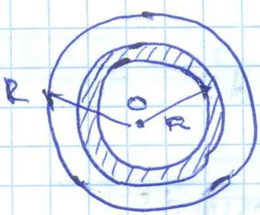
$$\Phi = 4\pi a^2 E$$

$$q = \frac{4}{3}\pi a^3 \rho$$

$$4\pi a^2 E = \frac{4}{3}\pi a^3 \frac{1}{\varepsilon_0}\rho$$

$\Rightarrow \quad E = \dfrac{a\rho}{3\varepsilon_0}$ или $\vec{E} = \dfrac{\vec{a}\rho}{3\varepsilon_0}$ (внутри шара)

способ 2:



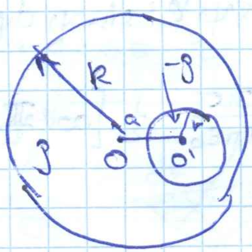
$$dq = \rho \cdot 4\pi a^2\, da$$

$$dE = \frac{k\, dq}{a^2}$$

$$E = \frac{Q'}{4\pi\varepsilon_0 a^2} = \frac{\frac{4}{3}\pi a^3 \rho}{4\pi\varepsilon_0 a^2} = \frac{\rho a}{3\varepsilon_0}$$

или $\vec{E} = \dfrac{\vec{a}\rho}{3\varepsilon_0}$ (внутри шара)

2) рассмотрим суперпозицию шаров



$$O': \vec{E}_б + \vec{E}_п = \frac{\rho\vec{a}}{3\varepsilon_0} - \frac{\rho\vec{0}}{3\varepsilon_0} = \frac{\rho\vec{a}}{3\varepsilon_0}.$$

напряж. от большого шара (без полости)

напряж. от „полости"

$\boxed{1.15}$ Из задачи 1.14 имеем:

$$\rho = \frac{Q}{\frac{4}{3}\pi R^3} \qquad E = \frac{kQa}{R^3} \Rightarrow E = \frac{kqa}{R^3}$$

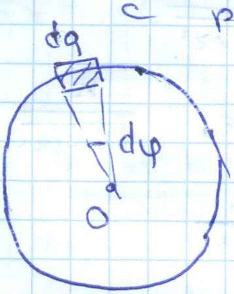
$$F = ma = -qE \qquad q = e$$

$$m\ddot{x} = -k\frac{q^2}{R^3}x$$

$$\ddot{x} + \frac{kq^2}{mR^3}x = 0 \Rightarrow \omega = \frac{q}{R}\sqrt{\frac{k}{mR}}$$

$$\nu = \frac{1}{T} = \frac{\omega}{2\pi} = \frac{q}{4\pi R}\sqrt{\frac{1}{\pi\varepsilon_0 R}}$$

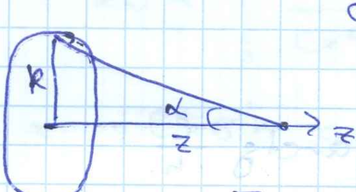
$\boxed{1.16}$ 1) Найдём напряжённость от кольца с равномерно распредел. зарядом q_0.



$$dq = \frac{q_0}{2\pi}d\varphi$$

$$dE = k\,dq\,\frac{1}{z^2+R^2}$$

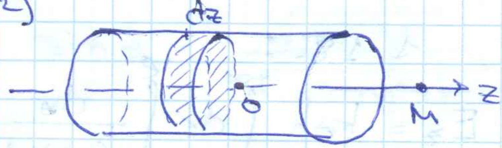
$$\cos\alpha = \frac{z}{\sqrt{z^2+R^2}}$$



$$dE_z = dE\cos\alpha = k\frac{q_0}{2\pi}d\varphi\frac{z}{(z^2+R^2)^{3/2}}$$

$$E_z = \int_0^{2\pi} dE_z = k\frac{q_0 z}{(z^2+R^2)^{3/2}}$$

2)



Положим: $q_0 = dq = \sigma\,dz\,2\pi R$

$$E_z = dE_z$$

O – середина цилиндра

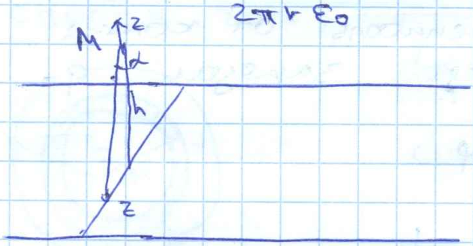
$$E_z^n = \int_{a-e}^{a+e} dE_z = 2\pi k R\sigma \int_{a-e}^{a+e} \frac{z\,dz}{(z^2+R^2)^{3/2}} =$$

$$= \frac{R\sigma}{2\pi\varepsilon_0}\left[-\frac{1}{\sqrt{R^2+z^2}}\right]\Bigg|_{a-e}^{a+e} =$$

$$= \frac{R\sigma}{2\pi\varepsilon_0}\left[\frac{1}{\sqrt{R^2+(a-e)^2}} - \frac{1}{\sqrt{R^2+(a+e)^2}}\right]$$

$\boxed{1.17}$ из задачи 1.5 имеем:

$$dE = \frac{\rho}{2\pi r\varepsilon_0}; \quad \rho = \sigma\,dz; \quad r = \sqrt{h^2+z^2}$$



$$\cos\alpha = \frac{h}{\sqrt{h^2+z^2}}$$

$$dE_z = \frac{\sigma\,dz}{2\pi\sqrt{h^2+z^2}\,\varepsilon_0}\cdot\frac{h}{\sqrt{h^2+z^2}} =$$

$$= \frac{\sigma}{2\pi\varepsilon_0}\frac{h\,dz}{h^2+z^2}$$

$$E_z = \int_{-e}^{e} dE_z = \frac{\sigma}{2\pi\varepsilon_0}\int_{-e}^{e}\frac{h\,dz}{h^2+z^2} =$$

$$= \frac{\sigma}{2\pi\varepsilon_0}\,\mathrm{arctg}\left(\frac{z}{h}\right)\Bigg|_{-e}^{e} = \frac{\sigma}{\pi\varepsilon_0}\,\mathrm{arctg}\,\frac{e}{h}.$$

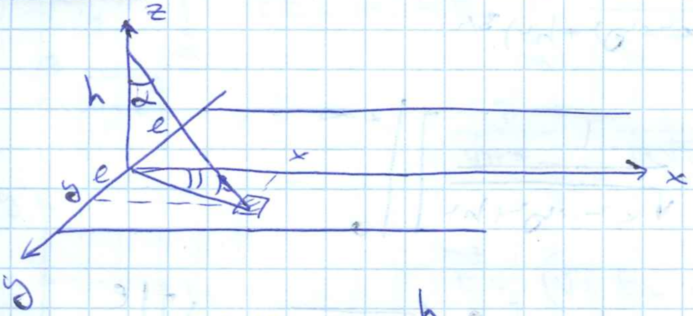
Возможно решение через разбиение полосы на прямоугольники, а не „нити".

Пример решения в задаче 1.18.:

$$dE_z = k\sigma h\frac{dx\,dy}{(x^2+y^2+h^2)^{3/2}} \qquad E_z = k\sigma h\int_{-\infty}^{+\infty}dx\int_{-e}^{e}\frac{dy}{(x^2+y^2+h^2)^{3/2}}$$

$$= \frac{\sigma}{\pi\varepsilon_0}\,\mathrm{arctg}\,\frac{e}{h}$$

$\boxed{1.18}$



$dq = \sigma\, dx\, dy$

$r_0 = \sqrt{x^2+y^2+h^2}$

$dE = \dfrac{k\,dq}{r_0^2} =$

$= k\sigma \dfrac{dx\,dy}{x^2+y^2+h^2}$

$\cos\alpha = \dfrac{h}{\sqrt{x^2+y^2+h^2}}$

$E_y = 0$ (в силу симметрии)

$$dE_z = k\sigma h \frac{dx\,dy}{(x^2+y^2+h^2)^{3/2}}$$

$$E_z = k\sigma h \int_0^{+\infty} dx \int_{-e}^{e} \frac{dy}{(x^2+y^2+h^2)^{3/2}} =$$

$$= k\sigma h \int_0^{+\infty} dx \left[\frac{y}{(x^2+h^2)\sqrt{x^2+y^2+h^2}} \right]\Bigg|_{-e}^{e} =$$

$$= k\sigma h \int_0^{+\infty} \frac{2e\,dx}{(x^2+h^2)\sqrt{x^2+\cancel{y}^2+h^2}} =$$

$$= 2ek\sigma h \operatorname{arctg}\left(\frac{ex}{h\sqrt{x^2+\cancel{h}^2+e^2}}\right)\Bigg|_0^{+\infty} \frac{1}{he} =$$

$$= \frac{\sigma}{2\pi\varepsilon_0} \operatorname{arctg}\frac{e}{h}$$

$$\sin\alpha = \frac{\sqrt{x^2+y^2}}{\sqrt{x^2+y^2+h^2}} \qquad \cos\beta = \frac{x}{\sqrt{x^2+y^2}}$$

$$dE_x = k\sigma \frac{x\,dx\,dy}{(x^2+y^2+h^2)^{3/2}}$$

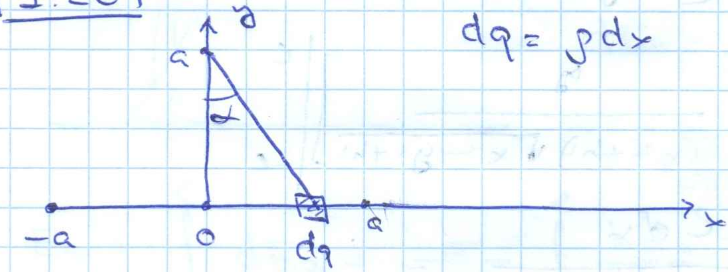
$$E_x = k\sigma \int_{-\ell}^{\ell} dy \int_{0}^{+\infty} \frac{x\,dx}{(x^2+y^2+h^2)^{3/2}} =$$

$$= k\sigma \int_{-\ell}^{\ell} dy \left[-\frac{1}{\sqrt{x^2+y^2+h^2}} \right] \Bigg|_0^{+\infty} =$$

$$= k\sigma \int_{-\ell}^{\ell} \frac{dy}{\sqrt{y^2+h^2}} = k\sigma \left[\ln\left(\sqrt{h^2+y^2}+y\right)\right]\Bigg|_{-\ell}^{\ell} =$$

$$= k\sigma \ln \frac{\sqrt{h^2+\ell^2}+\ell}{\sqrt{h^2+\ell^2}-\ell} \quad ; \quad k = \frac{1}{4\pi\varepsilon_0}$$

$\boxed{1.20}$



$$dq = \rho\,dx \qquad \cos\alpha = \frac{a}{\sqrt{a^2+x^2}}$$

$$\sin\alpha = \frac{x}{\sqrt{a^2+x^2}}$$

$$dE = \frac{k\,dq}{x^2+a^2} = k\rho \frac{dx}{x^2+a^2}$$

$$dE_y = dE\cos\alpha = k\rho a \frac{dx}{(x^2+a^2)^{3/2}}$$

$$dE_x = dE\sin\alpha = k\rho \frac{x\,dx}{(x^2+a^2)^{3/2}}$$

$$E_y = \int_{-a}^{+\infty} dE_y = k\rho a \int_{-a}^{+\infty} \frac{dx}{(x^2+a^2)^{3/2}} =$$

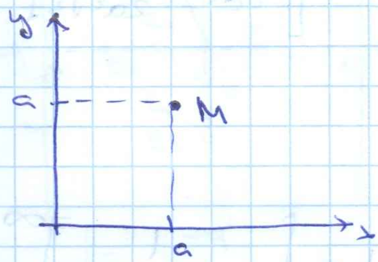
$$= k\rho a \left[\frac{x}{\sqrt{x^2+a^2}\;a^2} \right]_{-a}^{\infty} = k\rho a \left[\frac{1}{a^2} + \frac{1}{a^2\sqrt{2}} \right] =$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{\sqrt{2}+1}{a\sqrt{2}}$$

$$E_x = \int_a^{+\infty} dE_x = k\rho \int_a^{+\infty} \frac{x\,dx}{(x^2+a^2)^{3/2}} = k\rho \left[-\frac{1}{\sqrt{x^2+a^2}}\right]\Bigg|_a^{\infty} =$$

в силу симметрии

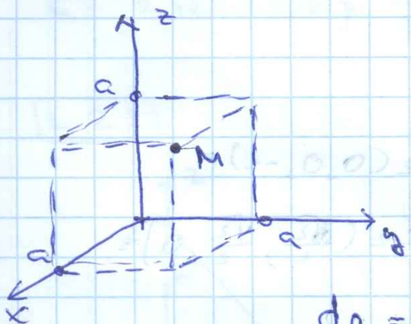
$$= \frac{\rho}{4\pi\varepsilon_0} \frac{1}{a\sqrt{2}}$$

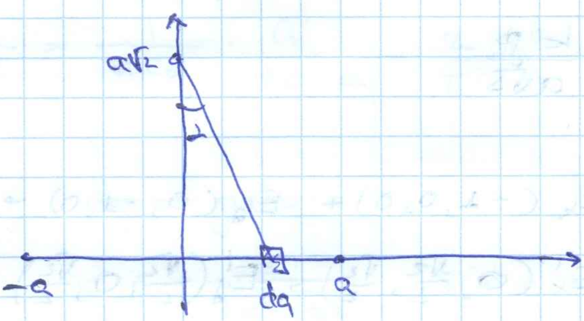


$$\vec{E} = (\sqrt{2}E_x - \sqrt{2}E_y)\vec{e} = \frac{\sqrt{2}\rho}{4\pi\varepsilon_0 a}\vec{e}$$

$$\vec{e} = \left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right).$$

$\boxed{1.21}$





$$dq = \rho\,dx$$

$$dE = \frac{k\,dq}{x^2+2a^2} \qquad \cos\alpha = \frac{a\sqrt{2}}{\sqrt{x^2+2a^2}} \qquad \sin\alpha = \frac{x}{\sqrt{x^2+2a^2}}$$

$$dE_x' = k\rho a\sqrt{2}\,\frac{dx}{(x^2+2a^2)^{3/2}}$$

$$dE_x = k\rho\,\frac{x\,dx}{(x^2+2a^2)^{3/2}}$$

$$E_x' = \int_{-a}^{+\infty} dE_x' = k\rho a\sqrt{2} \int_{-a}^{+\infty} \frac{dx}{(x^2+2a^2)^{3/2}} =$$

$$= k\rho a\sqrt{2} \left[\frac{x}{2a^2\sqrt{x^2+2a^2}} \right]_{-a}^{\infty} = k\rho a\sqrt{2} \left[\frac{1}{2a^2} - \frac{1}{2a^2\sqrt{3}} \right] =$$

$$= \frac{k\rho}{a\sqrt{3}\sqrt{2}} (\sqrt{3}+1).$$

$$E_x = \int_{a}^{+\infty} dE_x = k\rho \int_{a}^{+\infty} \frac{x\,dx}{(x^2+2a^2)^{3/2}} = k\rho \left[-\frac{1}{\sqrt{2a^2+x^2}} \right]_{a}^{\infty} =$$

$$= \frac{k\rho}{a\sqrt{3}}$$

$$\vec{E} = E_x(-1,0,0) + E_y(0,-1,0) + E_z(0,0,-1) +$$

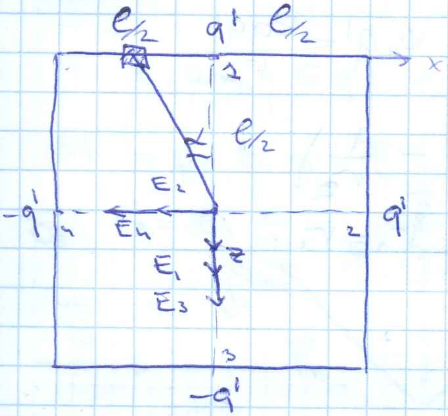
$$+ E_x'\left(0, \frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right) + E_y'\left(\frac{\sqrt{2}}{2}, 0, \frac{\sqrt{2}}{2}\right) + E_z'\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}, 0\right) =$$

$$= E_x(-1,-1,-1) + E_x'(\sqrt{2},\sqrt{2},\sqrt{2}) =$$

$$= -\sqrt{3}E_x\vec{e} + \sqrt{2}\sqrt{3}E_x'\vec{e} = \left[-\sqrt{3}\frac{k\rho}{a\sqrt{3}} + \sqrt{2}\sqrt{3}\frac{k\rho}{a\sqrt{3}\sqrt{2}}(\sqrt{3}+1) \right]\vec{e}$$

$$= \frac{\sqrt{3}k\rho}{a}\vec{e}, \quad \vec{e} = \left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}} \right)$$

$\boxed{1.19}$



$$a \equiv l/2 \qquad \rho = \frac{q'}{l} \qquad q' \equiv \frac{q}{2}$$

$$dq' = \rho\, dx \qquad dE = \frac{k\, dq'}{x^2+a^2} \qquad \cos\alpha = \frac{a}{\sqrt{x^2+a^2}}$$

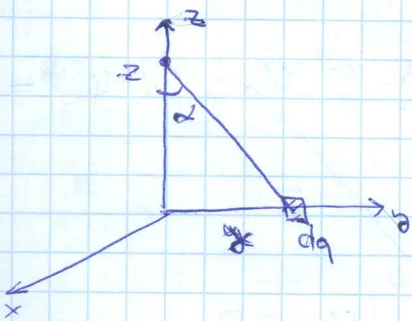
$$dE_z = k\rho a \frac{dx}{(x^2+a^2)^{3/2}}$$

$$E_z = k\rho a \int_{-a}^{a} \frac{dx}{(x^2+a^2)^{3/2}} =$$

$$= k\rho a \left[\frac{x}{a^2\sqrt{x^2+a^2}}\right]\Bigg|_{-a}^{a} = 2k\rho \frac{1}{a\sqrt{2}}$$

$$E = 2\sqrt{2} \cdot 2k\rho \frac{1}{a\sqrt{2}} = \frac{1}{\pi\varepsilon_0} \cdot \frac{q'}{2a \cdot a} = \frac{2q'}{\pi\varepsilon_0 l^2} = \frac{q}{\pi\varepsilon_0 l^2}$$

$\boxed{1.21}$



$$dq = \rho\, dx$$

$$\cos\alpha = \frac{z}{\sqrt{x^2+z^2}} \qquad \sin\alpha = \frac{x}{\sqrt{x^2+z^2}}$$

$$dE = \frac{k\, dq}{x^2+z^2}$$

$$dE_z = k\rho z \frac{dx}{(x^2+z^2)^{3/2}}$$

$$dE_y = k\rho \frac{x\, dx}{(x^2+z^2)^{3/2}}$$

$$E_z = \int_0^{+\infty} k\rho z \frac{dx}{(x^2+z^2)^{3/2}} = k\rho z \left[\frac{x}{z^2\sqrt{x^2+z^2}}\right]\Bigg|_0^{+\infty} = \frac{k\rho}{z} = E_0$$

$$E_y = \int_0^{+\infty} k\rho \frac{x\, dx}{(x^2+z^2)^{3/2}} = k\rho \left[-\frac{1}{\sqrt{x^2+z^2}}\right]\Bigg|_0^{+\infty} = \frac{k\rho}{z} = E_0$$

$$\vec{E} = 2E_z(0,0,1) + E_x(-1,0,0) + E_y(0,-1,0) =$$

$$= E_0(-1,-1,2) = \frac{\sqrt{6}\rho}{4\pi\varepsilon_0 z}\left(-\frac{1}{\sqrt{6}}, -\frac{1}{\sqrt{6}}, \frac{2}{\sqrt{6}}\right)$$