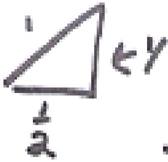


$$1^2 = \left(\frac{1}{2}\right)^2 + y^2$$

$$\Rightarrow y^2 = 1 - \frac{1}{4} = \frac{3}{4}$$

$$y = \frac{\sqrt{3}}{2} = 0.866$$

$$y_p = \frac{1}{2} y = 0.433$$

$$\vec{E}_p = k \sum_{i=1}^{3} \frac{q_i}{r_{ip}^{3/2}} \vec{r}_{ip}$$

$$\vec{r}_1 = -\frac{1}{2}\hat{x} + 0\hat{y} \qquad \vec{r}_2 = \frac{1}{2}\hat{x} + 0\hat{y}$$

$$\vec{r}_3 = 0\hat{x} + .866\hat{y}$$

$$\vec{r}_p = 0\hat{x} + .433\hat{y}$$

$$\vec{r}_p = 0\vec{x} + .433\vec{y}$$

$$\vec{r}_{1p} = \vec{r}_p - \vec{r}_1 = (0\vec{x} - \tfrac{1}{2}\vec{x}) + .433\vec{y}$$

$$\vec{r}_{2p} = \vec{r}_p - \vec{r}_2 = (0 - \tfrac{1}{2})\vec{x} + .433\vec{y}$$

$$\cancel{\vec{r}_{3p} = \vec{r}_p - \vec{r}_3 = (0-0)\vec{x} + (-.866)\vec{y}}$$

$$\vec{r}_{1p} = .5\vec{x} + .433\vec{y}$$

$$\vec{r}_{2p} = -.5\vec{x} + .433\vec{y}$$

$$\cancel{\vec{r}_{3p} = 0\vec{x} - .866\vec{y}}$$

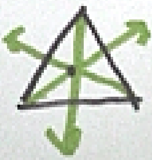
$$\vec{r}_{3p} = (0\vec{x} + .433\vec{y}) - (0\vec{x} + .866\vec{y})$$

$$= 0\vec{x} - .433\vec{y}$$

$$\vec{E}_p = kM\left[(+)\frac{.5\hat{x}+.433\hat{y}}{[.5^2+.433^2]^{3/2}}\right.$$

$$+\ (+)\frac{-.5\hat{x}+.433\hat{y}}{[.289]}$$

$$\left.+\ (+)\frac{0\hat{x}-.433\hat{y}}{[0^2+(.433)^2]^{3/2}}\right]$$

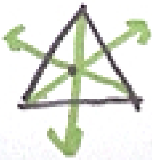


$$\vec{E}_p = kM\left[\frac{(.433\times 2)\hat{y}}{.289} - \frac{.433\hat{y}}{(.433)^3}\right]$$

$$= kM\left[\frac{.866}{.289} - 5.33\right]\hat{y}$$

$$+ (+) \frac{-.5\hat{x} + .433\hat{y}}{[.289]}$$

$$+ (+) \frac{0\hat{x} - .433\hat{y}}{[0^2 + (.433)^2]^{3/2}} \Bigg]$$



$$\vec{E}_p = k\mu \Bigg[\frac{(.433 \times 2)\hat{y}}{.289} - \frac{.433\hat{y}}{(.433)^3}$$

$$= k\mu \left[\frac{.866}{.289} - 5.33 \right] \hat{y}$$

4

$$= k\mu [2.99 - 5.33] \hat{y}$$

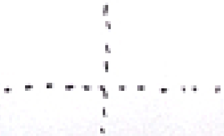
$$= k\mu [-2.34] \hat{y}$$

$$= -2.34(8990)\hat{y}$$

$$= -21010\hat{y}$$

$$= -2.1 \times 10^4 \hat{y} \frac{N}{C}$$

2

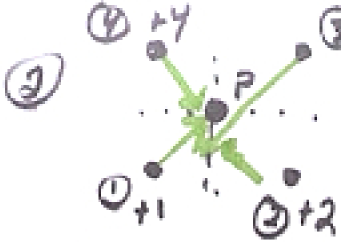


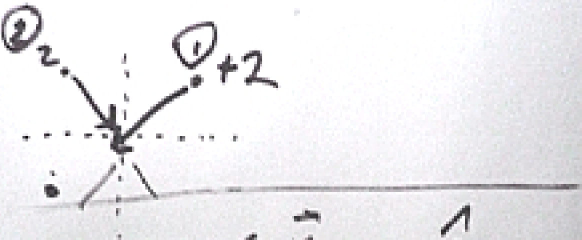
$$\vec{r}_{ip} = x\hat{x} + y\hat{y}$$

$$\frac{\vec{r}_{ip}}{|\vec{r}_{ip}|^{3/2}} \qquad \frac{x\hat{x} + y\hat{y}}{[x^2+y^2]^{3/2}}$$

$$\frac{\hat{r}_{ip}}{r_{ip}^2} = \frac{x\hat{x} + y\hat{y}}{[x^2+y^2]^{2/2}[x^2+y^2]^{1/2}}$$

$$= \frac{x\hat{x} + y\hat{y}}{[x^2+y^2]^{3/2}}$$



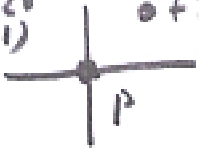


$$\vec{E}_p = k\mu \sum \frac{q_i \vec{r}_{ip}}{r_{ip}^3} \qquad \frac{\hat{r}_{ip}}{|\hat{r}_{ip}|^2}$$

$$|\vec{r}_{ip}| = \sqrt{x^2+y^2} = r_{ip}^{1/2}$$

$$\frac{1}{|\vec{r}_{ip}|} = |\hat{r}_{ip}|^{3} \frac{1}{[x^2+y^2]^{1/2}}$$

2 +2 (−1,1) • +2 (1,1) 1



$$\vec{r}_1 = 1\hat{x} + 1\hat{y}$$

$$\vec{r}_2 = -1\hat{x} + 1\hat{y}$$

$$\vec{r}_p = 0\hat{x} + 0\hat{y}$$

$$\vec{r}_{1p} = \vec{r}_p - \vec{r}_1 = -1\hat{x} - 1\hat{y}$$

$$\vec{r}_{2p} = 1\hat{x} - 1\hat{y}$$

$$\vec{E}_p = 2k\mu\left[\frac{-1\hat{x} - 1\hat{y}}{[1^2+1^2]^{3/2}} + \frac{1\hat{x} - 1\hat{y}}{[1^2+1^2]^{3/2}}\right]$$

$$\hat{r}_{2p} = 1\hat{x} - 1\hat{y}$$

$$\vec{E}_p = 2k\mu \left[\frac{-\cancel{1\hat{x}} - 1\hat{y}}{[1^2+1^2]^{3/2}} + \frac{\cancel{1\hat{x}} - 1\hat{y}}{[1^2+1^2]^{3/2}} \right]$$

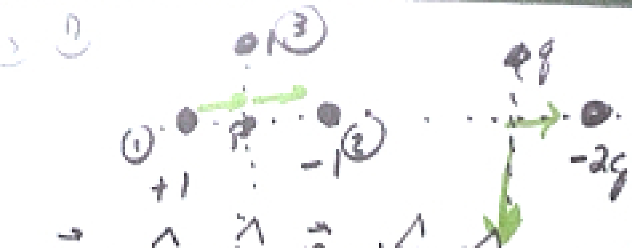
$$2.82$$

$$\vec{E}_p = \frac{2k\mu}{2.82}\left[-2\hat{y}\right]$$

$$= -\frac{4\,(8990)}{2.82}\hat{y}$$

$$= -(12751)\,\hat{y}\ \frac{N}{C}$$

$$= -1.275\times10^{4}\,\hat{y}\ \frac{N}{C}$$



$\vec{r}_1 = -\hat{x} + 0\hat{y}$ $\vec{r}_2 = 1\hat{x} + 0\hat{y}$

$\vec{r}_3 = 0\hat{x} + 1\hat{y}$ $\vec{r}_p = 0\hat{x} + 0\hat{y}$

$$\vec{E}_p = k\mu\left[(+)\frac{\hat{x} + 0\hat{y}}{[1^2+0^2]^{3/2}} + \frac{-\hat{x} + 0\hat{y}}{1}(-) + (+)\frac{0\hat{x} - 1\hat{y}}{1}\right]$$

8990

$$\vec{E}_p = k\mu\left[2\hat{x} - 1\hat{y}\right]$$
$$= 17980\hat{x} - 8990\hat{y}$$

$$\underline{\vec{E}_p = 1.798\times10^4\hat{x} - 8.99\times10^3\hat{y}\ \frac{N}{C}}$$

(4)
22U-4

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

outside

choose a GS
$r \geq a$

on GS: $\vec{E} \parallel \vec{A}$
$|\vec{E}|$ constant

$$\oiint \vec{E}\cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0} \qquad \sum \vec{E}_i \cdot \Delta\vec{A}_i = \frac{q_{enc}}{\varepsilon_0}$$

$\vec{E} \iint dA$ $\qquad \Delta A_i$
$\qquad E \sum \Delta A_i$

$q_{enc} = 0 \Rightarrow$
$$\vec{E}_{out} = 0\,\hat{r}$$

(4)
22U-4

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

outside

choose a GS

$r \geq a$

on GS: $\vec{E} \parallel \vec{A}$

$|\vec{E}|$ constant

$\oint \vec{E}\cdot d\vec{A} = \frac{q_{enc}}{\epsilon_0}$ $\sum \vec{E}_i \cdot \Delta\vec{A}_i = \frac{q_{enc}}{\epsilon_0}$

$\vec{E}\oint dA$ ΔA_i

$E \sum \Delta A_i$

$q_{enc} = 0 \Rightarrow$

$\vec{E}_{out} = 0\,\hat{r}$

$E(4\pi r^2) = \frac{q_{enc}}{\epsilon_0}$ | $E(4\pi r^2) = \frac{q_{enc}}{\epsilon_0}$

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

$\vec{E} = \frac{1}{\epsilon_0}\int \frac{3Q}{\ldots} r - \frac{Q}{\ldots}\hat{r}$

+4.

$Q_{enc} = \iiint \rho \cdot d^3r$

Chouse a GS center on charge

$r \leq a$

Seperate & superimpose

on GS: $\vec{E} \parallel \vec{A}$

$|\vec{E}| = const$

$$\oiint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\varepsilon_0}$$

$$\oiint E\, dA = \frac{Q_{enc}}{\varepsilon_0}$$

$$E \oiint dA = \frac{Q_{enc}}{\varepsilon_0}$$

$$E(4\pi r^2) = \frac{Q_{enc}}{\varepsilon_0}$$

$$\sum_{\Delta A_i} \vec{E}_i \cdot \Delta\vec{A}_i = \frac{Q_{enc}}{\varepsilon_0}$$

$$\sum E_i \cdot \Delta A_i = \frac{Q_{enc}}{\varepsilon_0}$$

$$E \sum \Delta A_i = \frac{Q_{enc}}{\varepsilon_0}$$

$$E(4\pi r^2) = \frac{Q_{enc}}{\varepsilon_0}$$

$4\pi a 3$

$\frac{3Q}{3(4\pi}$

$+q$:

$r < R$

$$Q_{enc} = \iiint \rho \cdot d^3r$$

$$= 4\pi \int_0^r \rho \cdot r^2 dr$$

$$= 4\pi\rho \int_0^r r^2 dr$$

$$= \frac{4}{3}\pi\rho r^3$$

$r \leq R$

$$Q_{enc} = \rho \cdot \frac{4}{3}\pi r^3$$

$$\vec{E}_{+q} = \frac{\rho\left(\frac{4}{3}\pi r^3\right)}{\varepsilon_0 (4\pi r^2)}\vec{r} = \frac{\rho}{3\varepsilon_0} r \hat{r}$$

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

superimpose

$$\vec{E} = \vec{E}_{+q} + \vec{E}_{-q} = \left[\frac{\rho}{3\varepsilon_0} r - \frac{Q}{4\pi\varepsilon_0 r^2}\right]\hat{r}$$

superimpose

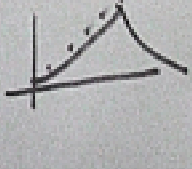
$$\vec{E} = \vec{E}_{+q} + \vec{E}_{-q} = \left[\frac{\rho}{3\varepsilon_0} r - \frac{q}{4\pi\varepsilon_0 r^2}\right]\hat{r}$$

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

$$\vec{E} = \frac{1}{\varepsilon_0}\left[\frac{3q}{3(4\pi a^3)} r - \frac{q}{4\pi r^2}\right]\hat{r}$$

$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{r}{a^3} + \frac{-1}{r^2}\right]\hat{r} \quad (r \le a)$$

$$\frac{1}{a^2} - \frac{1}{a^2} = 0$$



250

4: $\rho = \rho_0 \frac{r}{a}$

GS: $r > a$, centered

On GS: $|\vec{E}| = \text{const}$

$$\vec{E} \parallel \vec{n}$$

$$\oiint \vec{E} \cdot d\vec{a} = \frac{Q_{enc}}{\varepsilon_0}$$

$$E(4\pi r^2) = \frac{Q_{enc}}{\varepsilon_0}$$

$$Q_{enc} = \iiint \rho \, d^3r = \frac{4\pi\rho_0}{a} \int_0^{r=a} r \, r^2 dr$$

$$= \frac{4\pi\rho_0}{a} \cdot \frac{a^4}{4} = \pi\rho_0 a^3$$

$$\vec{E}_{out} = \frac{4\pi\rho_0 a^3}{\varepsilon_0 (4\pi r^2)} \hat{r}$$

$$= \frac{\rho_0 a^3}{4\varepsilon_0 r^2} \hat{r}$$

$$\vec{E} \parallel \hat{r}$$

$$\oiint \vec{E} \cdot d\vec{a} = \frac{q_{enc}}{\varepsilon_0}$$

$$E(4\pi r^2) = \frac{q_{enc}}{\varepsilon_0}$$

$$q_{enc} = \iiint \rho \, d^3r = \frac{4\pi\rho_0}{a} \int_0^{r=a} r \, r^2 dr$$

$$= \frac{4\pi\rho_0}{a} \cdot \frac{a^4}{4} = \pi\rho_0 a^3$$

$$\vec{E}_{out} = \frac{\pi\rho_0 a^3}{\varepsilon_0 (4\pi r^2)} \hat{r}$$

$$= \frac{\rho_0 a^3}{4\varepsilon_0 r^2} \hat{r}$$

inside

$r \le a$

Ongs:

$|\vec{E}|$ uniform, $\vec{E} \parallel \vec{A}$

$$\oiint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\varepsilon_0}$$

$$E(4\pi r^2) = \frac{Q_{enc}}{\varepsilon_0}$$

$$Q_{enc} = \iiint \rho \, d^3r = \frac{4\pi\rho_0}{a\varepsilon_0} \int_0^r r \cdot r^2 \, dr$$

$$= \frac{4\pi\rho_0}{a\varepsilon_0} \cdot \frac{r^4}{4} = \frac{\pi\rho_0 r^4}{\varepsilon_0 a}$$

[illegible], $\vec{E} \parallel \vec{A}$

$$\oint\!\!\oint_{P} \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\varepsilon_0}$$

$$E(4\pi r^2) = \frac{Q_{enc}}{\varepsilon_0}$$

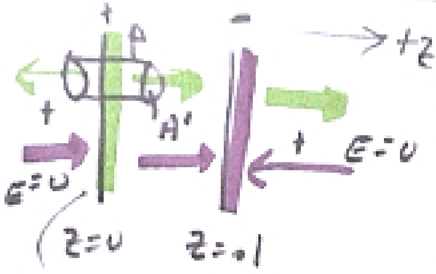
$$Q_{enc} = \iiint \rho \, d^3r = \frac{4\pi\rho_0}{a\varepsilon_0} \int_0^r r \cdot r^2 dr$$

$$= \frac{4\pi\rho_0}{a\varepsilon_0} \cdot \frac{r^4}{\cancel{4}} = \frac{\pi\rho_0 r^4}{\varepsilon_0 a}$$

Inside:

$$\vec{E} = \frac{\pi\rho_0 r^4}{(4\pi r^2)\, a\varepsilon_0} \hat{r}$$

$$\vec{E}_{in} = \frac{\rho_0 r^2}{4a\varepsilon_0} \hat{r} \quad // \quad \frac{Q}{4\pi\varepsilon_0 r^2} \hat{r}$$



$\sigma = \frac{Q}{A} = \frac{1\mu}{1m^2}$

$A: 1\,m^2$ On LSA: $\vec{A} \perp \vec{E}$

$\vec{E}\cdot\vec{A} = 0$

on Ends: $\vec{A}$, $\vec{E}$, A'

$\vec{E}\cdot\vec{A} = EA$

$\vec{E} \parallel \vec{A}$, $|\vec{E}|$ uniform

$\Phi_E = \frac{Q_{enc}}{\varepsilon_0} \Rightarrow \Phi_E = EA'$

$Q_{enc} = \sigma A'$

$$EA' = \frac{\sigma A'}{\varepsilon_0} \Rightarrow \vec{E}_{in} = \frac{\sigma}{\varepsilon_0}\hat{n}$$

$$\vec{E}_{out} = 0\hat{n}$$

$$E = \frac{F}{q}$$

$$F = Eq$$