251.02
22

1: $(1\mu; -1, 0)$
2: $(-1\mu; 1, 0)$
3: $(1\mu; 0, 1)$
P: $(0, 0)$

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

$\vec{r}_{ip} = \vec{r}_p - \vec{r}_i$

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

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

$\vec{r}_{1p} = +1\hat{x}+0\hat{y}$ $\quad \vec{r}_{2p} = -1\hat{x}+0\hat{y}$

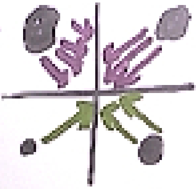
$\vec{r}_{3p} = 0\hat{x}-1\hat{y}$ $\quad [0^2+1^2]^{3/2} = 1$

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

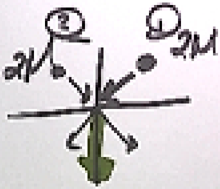
$$\vec{E}_p = k\mu\left[2\hat{x} + -1\hat{y}\right]$$

$$= 17980\hat{x} - 8990\hat{y}\ \frac{N}{C} = 1.8\times10^{4}\hat{x} - 8.99\times10^{3}\hat{y}$$

N/C



1: (M;1,1)
2: (2M;1,-1)
3: (3M;1,1)
4: (4M;-1,1)
P: (0,0)



1: (2M;1,1)
2: (2M;-1,1)
P: (0,0)

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

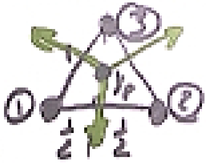
$\vec{r}_{2p} = +1\hat{x} - 1\hat{y}$

$[1^2+1^2]^{3/2} = 2.82$

$$\vec{E}_p = 2\mu k\left[+\frac{-1\hat{x}-1\hat{y}}{2.82} + \frac{+1\hat{x}-1\hat{y}}{2.82}\right]$$

$$= \frac{2}{2.82}\mu k\left[0\hat{x} - 2\hat{y}\right] = 1.42(8990)\left[0\hat{x} - 1\hat{y}\right]$$

$$= 0\hat{x} - 1.28\times 10^{4}\,\hat{y}\ \frac{N}{C}$$



1

$$?^2 = 1^2 - \left(\frac{1}{2}\right)^2 = 1 - \frac{1}{4} = \frac{3}{4}$$

$$? = \frac{\sqrt{3}}{2}$$

① : $(1M; -\frac{1}{2}, 0)$

② : $(1M; \frac{1}{2}, 0)$

③ : $(1M; 0, \frac{\sqrt{3}}{2})$

Ⓟ : $(0, \frac{\sqrt{3}}{4})$

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

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

$$\vec{r}_3 = 0\hat{x} + \frac{\sqrt{3}}{2}\hat{y}$$

$$\vec{r}_p = 0\hat{x} + \frac{\sqrt{3}}{4}\hat{y}$$

$$\vec{r}_{1p} = +\frac{1}{2}\hat{x} + \frac{\sqrt{3}}{4}\hat{y}$$

$$\vec{r}_{2p} = -\frac{1}{2}\hat{x} + \frac{\sqrt{3}}{4}\hat{y}$$

$$\vec{r}_{3p} = 0\hat{x} + \left(\frac{\sqrt{3}}{4} - \frac{\sqrt{3}}{2}\right)\hat{y} = 0\hat{x} - \frac{\sqrt{3}}{4}\hat{y}$$

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

$$\vec{r}_{1p} = \frac{1}{2}\hat{x} + \frac{\sqrt{3}}{4}\hat{y} \qquad \vec{r}_{2p} = -\frac{1}{2}\hat{x} + \frac{\sqrt{3}}{4}\hat{y}$$

$$\vec{r}_{3p} = 0\hat{x} - \frac{\sqrt{3}}{4}\hat{y}$$

$$\left[\left(\frac{1}{2}\right)^2 + \left(\frac{\sqrt{3}}{4}\right)^2\right]^{3/2} = \left[\frac{1}{4} + \frac{3}{16}\right]^{3/2}$$

$$= \left(\frac{7}{16}\right)^{3/2} = \cancel{0.44}\ .289$$

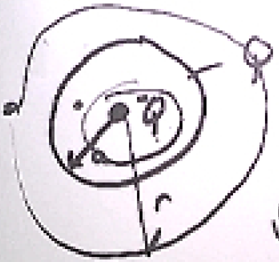
$$\left[\left(\frac{\sqrt{3}}{4}\right)^2\right]^{3/2} = \left(\frac{\sqrt{3}}{4}\right)^3 = .081$$

$$\vec{E}_p = k\mu\left[\frac{\frac{1}{2}\hat{x} + \frac{\sqrt{3}}{4}\hat{y}}{.289} + \frac{-\frac{1}{2}\hat{x} + \frac{\sqrt{3}}{4}\hat{y}}{.289} + \frac{0\hat{x} - \frac{\sqrt{3}}{4}\hat{y}}{.08}\right]$$

$$= k\mu\left[\frac{\frac{\sqrt{3}}{2}}{.289} - \frac{\frac{\sqrt{3}}{4}}{.08}\right]\hat{y} =$$

$$= k\mu\left[3.0 - 5.4\right]\hat{y} = -2.4\mu k\hat{y} + 0\hat{x}$$

$$\vec{E} = 0\hat{x} - 2.17\times10^{4}\,\hat{y}\ \frac{N}{C}$$



$r>a$

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

$\Phi_E = \frac{q_{enc}}{\varepsilon_0}$

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

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

$E_{-q} + E_q$

$\vec{E}_{-q}: \sum_{\Delta A_i} \vec{E}_i \cdot \Delta\vec{A}_i = \Phi_E$

$\Phi_E = \sum E_i \Delta A_i = E \sum \Delta A_i$

$= E(4\pi r^2)$

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

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

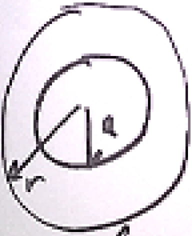
$$Q_{enc} = \rho\left(\frac{4}{3}\pi r^3\right) = Q\left(\frac{r}{a}\right)^3$$

$$Q_{enc} = \iiint \rho \, d^3r = 4\pi \frac{Q}{\frac{4}{3}\pi a^3} r^3$$

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

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

@ $r = a$, $E = 0$



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

$r > a$ on GS: $\vec{E} \parallel \vec{A}$

E uniform

$\oint_E = \frac{Q_{enc}}{\varepsilon_0}$

outside

$\underline{Q_{enc}} = \iiint \rho \, d^3r = 4\pi \int \rho \cdot r^2 dr$

$$\oint = \oint \vec{E} \cdot d\vec{A} = 4\pi \int_0^a \rho_0 \frac{r}{a} \cdot r^2 dr$$

$$= \oint E dA = \frac{4\pi\rho_0}{a} \int_0^a r^3 dr = \frac{4\pi\rho_0}{a} \frac{a^4}{4}$$

$$= E \oint dA$$

$$= E(4\pi r^2) \quad Q_{enc} = \pi\rho_0 a^3$$

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

r<a: on GS

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

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

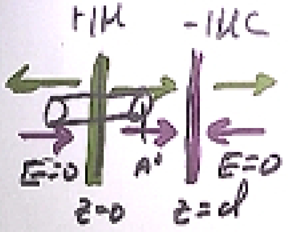
$$= 4\pi \int_0^r \rho_0 \frac{r}{a} r^2 \, dr$$

$$= \frac{4\pi\rho_0}{a} \int_0^r r^3 \, dr = \frac{\pi \rho_0 r^4}{a}$$

$$\Phi_E = \oiint \vec{E} \cdot d\vec{A} = \oiint E \, dA = E \oiint dA$$

$$= E(4\pi r^2)$$

$$\vec{E} = \frac{\rho_0 r^4}{4ar^2\epsilon_0}\hat{r} = \frac{\rho_0 r^2}{4a\epsilon_0}\hat{r}$$



$A = 1\,m^2$

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

on LSA $\quad \sigma = 1\,\mu C/m^2$

$\hat{E} \perp \vec{A}$

on END: $\hat{E} \parallel \vec{A}$, and

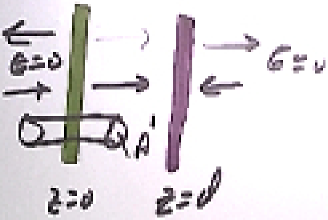
$$\Phi_E = \frac{Q_{enc}}{\epsilon_0}$$

on other end: $E = 0$

$$\Phi_E = \sum_{\Delta A_i} \vec{E}_i \cdot \Delta \vec{A}_i = \sum E_i \Delta A_i = E \sum \Delta A_i$$
$$= EA'$$

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \oint E\,dA = E \oint dA$$
$$= EA'$$

$$EA' = \frac{\sigma A'}{\epsilon_0} \Rightarrow \boxed{\vec{E} = \frac{\sigma}{\epsilon_0}\hat{z}}$$



On LSA:
$\bar{E} \perp \bar{A}$

on end1: $\bar{E} \parallel \bar{A}$
E un. A_1

on end2: $E = 0$

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

$$\vec{E} = \frac{\sigma}{\varepsilon_0}\hat{z} \qquad \sigma = 1\,\mu C/m^2$$

$$\varepsilon_0 = 8.8\times10^{-12}\,\frac{C^2}{Nm^2}$$

$$\vec{E} = \frac{1\times10^{-6}}{8.8\times10^{-6}\times10^{-6}} = \frac{1}{8.8\times10^{-6}}\hat{z}$$

$$= 0.11\times10^{6}\,\frac{N}{C}\,\hat{z} = 1.1\times10^{5}\,\frac{N}{C}\,\hat{z}$$

$$Vol = \frac{4}{3}\pi(a^3 - b^3)$$

$$\rho = \frac{Q}{\frac{4}{3}\pi(a^3 - b^3)}$$

outside: $\Phi_E = \frac{q_{enc}}{\varepsilon_0}$ Choose GS $r > a$, $\vec{E} \parallel \hat{n}$, E unif.

$$\Phi_E = E(4\pi r^2) \qquad \vec{E}_{out} = \frac{Q}{4\pi\varepsilon_0 r^2}\hat{r}$$

$q_{enc} = Q$

r<b:

on GS

$\vec{E} \parallel \vec{A}$, unif.

$Q_{enc} = 0$

$\phi_E = E(4\pi r^2)$

$E = 0 \quad (r<b)$

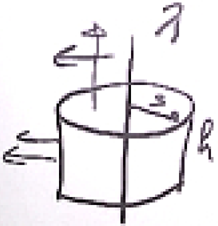
---

b<r<a $\quad Q_{enc} = \rho V_{ol} = \frac{Q}{\frac{4}{3}\pi(a^3-b^3)} \cdot \left[\frac{4}{3}\pi(r^3-b^3)\right]$

$= Q\left(\frac{r^3-b^3}{a^2-b^3}\right)$

$\Phi_E = E(4\pi r^2)$

$\vec{E} = \frac{Q}{4\pi\varepsilon_0 r^2}\left(\frac{r^3-b^3}{a^2-b^3}\right)\hat{r}$



$\vec{E}$

On LSA: $\vec{E} \parallel \hat{A}$, uniform

On ENDS: $\vec{E} \perp A$

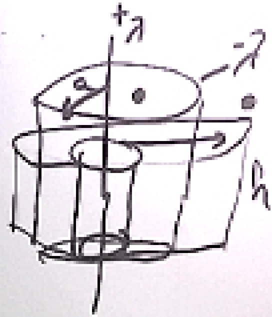
$q_{enc} = \lambda h$

$$\Phi_E = \sum_{\Delta A_i} \vec{E}_i \cdot \Delta \vec{A}_i$$

$$= \sum_{LSA} E_i \Delta A_i = E(2\pi s h)$$

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \oint E\,dA = E(2\pi s h)$$

$$E(2\pi s h) = \frac{\lambda h}{\varepsilon_0} \Rightarrow \vec{E} = \frac{\lambda}{2\pi s \varepsilon_0}\hat{s}$$



O.G.S.: $E \parallel \partial_{LSA}$

$E \perp$ ENDS

$\Phi_E = E(2\pi s h)$

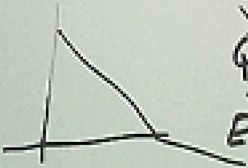
$q_{enc} = 0$

$\Rightarrow \underline{E = 0 \text{ outside}}$

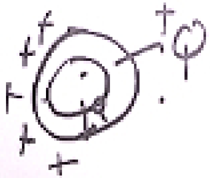
In:

$\Phi = E(2\pi s h)$

$q_{enc} = \lambda h$



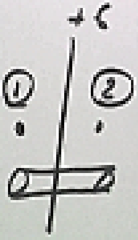
$\vec{E} = \dfrac{\lambda}{2\pi s h \varepsilon_0} \hat{s}$



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

<u>outside</u>

IN: $E(4\pi r^2) = 0 \Rightarrow \vec{E} = 0\hat{r}$



$$\Delta\vec{E} = ?$$

$$2EA' = \frac{\sigma A'}{\varepsilon_0}$$

$$\vec{E} = \frac{\sigma}{2\varepsilon_0}\begin{cases} +\hat{z}; & z>0 \\ -\hat{z}; & z<0 \end{cases}$$

$$\Delta\vec{E} = \vec{E}_2 - \vec{E}_1 = \frac{\sigma}{2\varepsilon_0}\hat{z} - \frac{\sigma}{2\varepsilon_0}(-\hat{z})$$

$$\vec{E} = \frac{\sigma}{\varepsilon_0}\hat{z}$$ Discont.