N20
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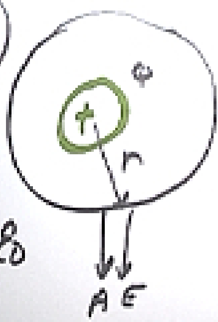


$$\vec{E} = k\frac{q}{r^2}\hat{r}$$

$$k = \frac{1}{4\pi\varepsilon_0}$$

On GS:

$\vec{E} \parallel \vec{A}$

E uniform

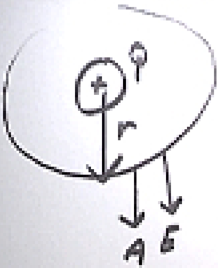
$$\Phi_E = \frac{q_{enc}}{\varepsilon_0} = \frac{q}{\varepsilon_0}$$

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

$$= \sum_{\Delta A_i} E_i \Delta A_i = E \sum_{\Delta A_i} \Delta A_i$$

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

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



ON GS:

$\vec{E} \parallel \vec{A}$

E uniform

$$\Phi_E = \frac{q_{enc}}{\epsilon_0} = \frac{q}{\epsilon_0}$$

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

$$= \sum_{\Delta A_i} E_i \Delta A_i = E \sum_{\Delta A_i} \Delta A_i$$

$$= E(4\pi r^2) = \frac{q}{\epsilon_0}$$

$$\vec{E} = \frac{q}{4\pi\epsilon_0 r^2}\hat{r}$$

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

$$q_{enc} = Q$$

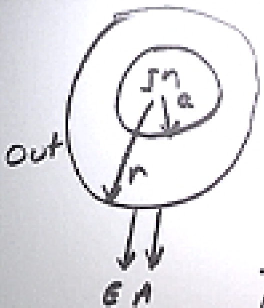
$$\vec{E} \parallel \vec{A}, \ E \text{ uniform}$$

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

$$= E \sum_{\Delta A_i} \Delta A_i = E(4\pi r^2)$$

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

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



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

Outside

$$Q_{enc} = Q$$

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

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

$$= E \sum_{\Delta A_i} \Delta A_i = E(4\pi r^2)$$

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

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

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

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

$$Q_{enc} = \rho V_{volume}$$

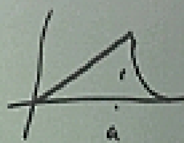
$$= \rho\left(\frac{4}{3}\pi r^3\right)$$

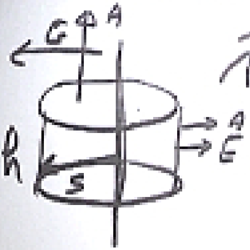
$$\Phi_E = \sum_{\Delta A_i} \vec{E}_i \cdot \Delta\vec{A}_i = \sum_{\Delta A_i} E_i \, \Delta A_i$$

$$= E \sum_{\Delta A_i} \Delta A_i = E\left(4\pi r^2\right)$$

$$E\left(4\pi r^2\right) = \frac{\rho}{\varepsilon_0}\left(\frac{4}{3}\pi r^3\right)$$

$$E = \frac{\rho}{3\varepsilon_0} r$$





$$\lambda = \frac{Q}{L}$$

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

E uniform

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

$$Q_{enc} = \lambda h$$

$$\oint_E = \oint_{ENDS} + \oint_{LSA}$$

$\vec{E} \perp \vec{A}$ on ENDS

$\Rightarrow 0$

$$\oint_{ENDS} = 0$$

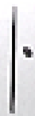
$$\oint = \sum_{\Delta A_i} \vec{E}_i \cdot \Delta \vec{A}_i = \sum_{\Delta A_i} E_i \, \Delta A_i$$

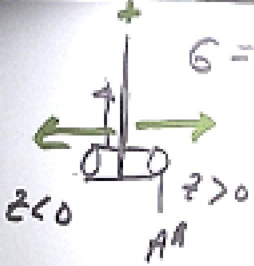
$$= E \sum \Delta A_i = E(2\pi s h)$$

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

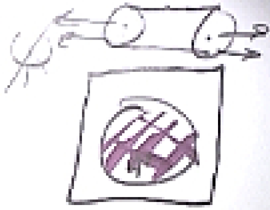
$$E(2\pi s h) = \frac{\lambda h}{\varepsilon_0}$$

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





$$\sigma = \frac{Q}{A}$$



$$Q_{enc} = \sigma A'$$

on LSA: $\vec{E} \perp \vec{A}$

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

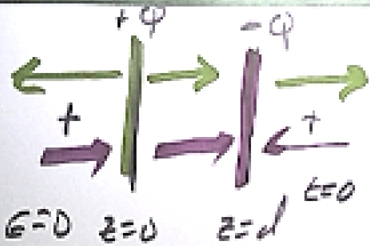
$$\Phi_E = \cancel{\Sigma}\,\Phi_{LSA} + \Phi_{ENDS}$$

$$= 0 + 2\sum_{\Delta A_i} \vec{E}_i \cdot \Delta\vec{A}_i = 2EA'$$

$$2EA' = \frac{\sigma A'}{\varepsilon_0} \Rightarrow \vec{E} = \frac{\sigma}{2\varepsilon_0}\begin{cases} +\hat{z}, & z>0 \\ -\hat{z}, & z<0 \end{cases}$$

$$2\sum_{\Delta A_i} \vec{E}_i \cdot \Delta\vec{A}_i = 2\sum_{\Delta A_i} E_i \Delta A$$

$$= 2E\sum_{\Delta A_i} \Delta A_i = 2EA' = \Phi_E$$



Stand wed