

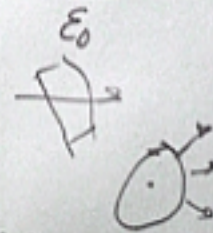
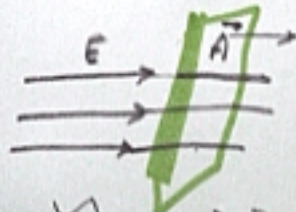
1220

Gauss' Law

⊕



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



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

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



$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0}$$

On GS:

$$\oint \vec{E} \cdot d\vec{A} = \sum \vec{E}_i \cdot \vec{\Delta A}_i$$

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

$|\vec{E}|$ constant

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

$$= \underline{E(4\pi r^2)}$$



$$\oint \vec{E} = \frac{Q_{enc}}{\epsilon_0}$$

ON GS:

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

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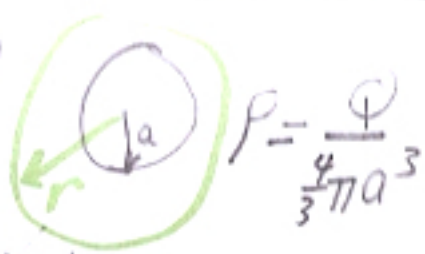
$$Q_{enc} = Q$$

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

$$\vec{E} = \frac{Q}{4\pi \epsilon_0 r^2} \hat{r} \quad \parallel \quad \vec{E} = \frac{kQ}{r^2} \hat{r}$$

$$k = \frac{1}{4\pi \epsilon_0}$$

6)



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

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

$$\Phi_E = \frac{Q_{enc}}{\epsilon_0} \quad |\vec{E}| \text{ uniform} \quad \boxed{Q_{enc} = Q}$$

$$\begin{aligned} \Phi_E &= \sum_{\Delta A_i} \vec{E}_i \cdot \Delta \vec{A}_i = \sum_{\Delta A_i} E_i \Delta A_i \\ &= E \sum_{\Delta A_i} \Delta A_i = E (4\pi r^2) \end{aligned}$$

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

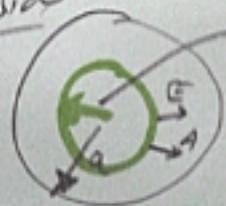
$$\oint_{\text{LH}} \vec{E} \cdot d\vec{l} = \frac{Q_{\text{enc}}}{\epsilon_0} \quad \left[Q_{\text{enc}} = Q \right]$$

$$\oint \vec{E} \cdot d\vec{l} = \oint E \cdot \vec{n} \cdot dA$$

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

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

Inside



$r \leq a$

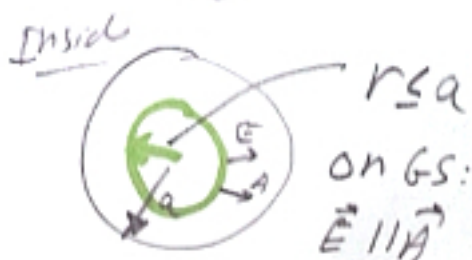
ON GS:
 $\vec{E} \parallel \vec{A}$

$|\vec{E}|$ uniform

$$\oint_{\text{LH}} \vec{E} \cdot d\vec{l} = \frac{Q_{\text{enc}}}{\epsilon_0}$$

$$\oint_{\text{LH}} \vec{E} \cdot d\vec{l} = E(4\pi r^2)$$

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

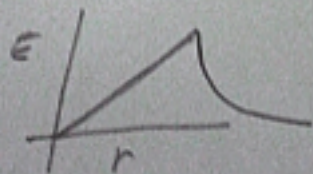


$$Q_{enc} = \rho \cdot \text{Volume}$$

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

$$E(4\pi r^2) = \frac{\rho}{\epsilon_0} \left(\frac{4}{3} \pi r^3 \right)$$

$$\vec{E} = \frac{\rho}{\epsilon_0} \vec{r} \quad \text{in } \rho = \frac{4}{3} \pi a^3$$



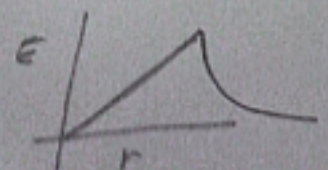
$r \leq a$
 on GS:
 $\vec{E} \parallel \vec{A}$
 $|\vec{E}|$ uniform
 $\oint \vec{E} = \frac{Q_{enc}}{\epsilon_0}$
 $\oint \vec{E} = E(4\pi r^2)$

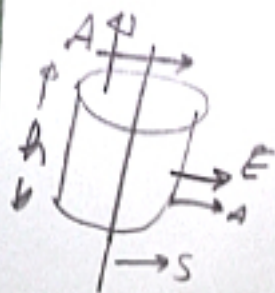
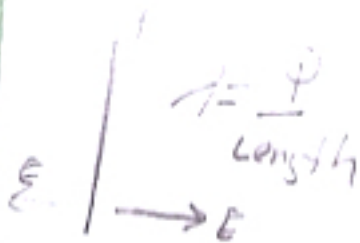
$$Q_{enc} = \rho \cdot \text{Volume}$$

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

$$E(4\pi r^2) = \frac{\rho}{\epsilon_0} \left(\frac{4}{3} \pi r^3 \right)$$

$$\vec{E} = \frac{\rho}{\epsilon_0} \vec{r} \quad \text{in } \rho = \frac{Q}{\frac{4}{3} \pi a^3}$$





O.A.G.S:
 ENDS: $\vec{E} \perp \vec{A}$

LSA: $\vec{E} \parallel \vec{A}$, $|\vec{E}|$ const

$$\oint_{\mathcal{V}} \vec{E} = \frac{Q_{\text{enc}}}{\epsilon_0}$$

$$\oint_{\mathcal{V}} \vec{E} = \sum_{\Delta A_i} \vec{E}_i \cdot d\vec{A}_i$$

$$= \sum_{\substack{\Delta A_i \\ \text{ENDS}}} \vec{E}_i \cdot d\vec{A}_i + \sum_{\substack{\Delta A_i \\ \text{LSA}}} \vec{E} \cdot d\vec{A}_i$$

$$= 0 + E \sum_{\text{LSA}} \delta A_i$$

$$\oint_{\mathcal{V}} \vec{E} = E(2\pi r s)$$

$$\oint_{\text{LSD}} \vec{E} \cdot d\vec{A}$$

LSD: $\vec{E} \parallel \vec{A}$, $|\vec{E}|$ const

$$\oint_{\text{LSD}} \vec{E} = \frac{Q_{\text{enc}}}{\epsilon_0}$$

$$\oint_{\text{LSD}} \vec{E} = \sum_{\text{LSD}} \vec{E}_i \cdot \delta \vec{A}_i$$

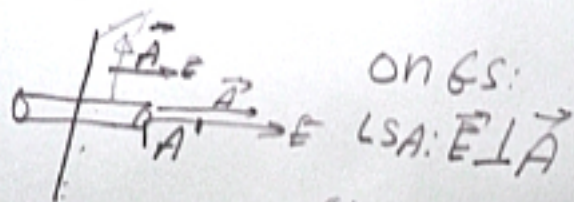
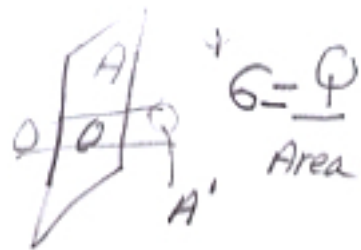
$$= \sum_{\text{ENDS}} \vec{E}_i \cdot \delta \vec{A}_i + \sum_{\text{LSA}} \vec{E} \cdot \delta \vec{A}_i$$

$$= 0 + E \sum_{\text{LSA}} \delta A_i$$

$$\oint_{\text{LSD}} \vec{E} = E(2\pi r h) \quad // \quad Q_{\text{enc}} = \lambda h$$

$$E(2\pi r h) = \frac{\lambda h}{\epsilon_0}$$

$$\vec{E} = \frac{\lambda}{2\pi \epsilon_0 r} \hat{s}$$

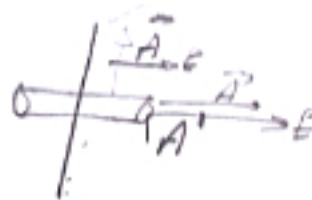


ON ENDS
 $\vec{E} \parallel \vec{A}$

$$\oint_{\text{LSE}} \vec{E} = \frac{Q_{\text{enc}}}{\epsilon_0}$$

$$\oint \vec{A} \cdot d\vec{A} = \Psi$$

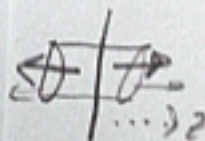
Area



ON GS: LSA: $\vec{E} \perp \vec{A}$

ON ENDS

$$\Phi_E = \Phi_{\text{ENDS}} + \Phi_{\text{LSA}}$$



ON ENDS

$$\Phi_{\text{LSA}} = \sum \vec{E}_i \cdot \delta \vec{A}_i$$

$$= 0$$

$$\Phi_{\text{ENDS}} = \sum \vec{E}_i \cdot \delta \vec{A}_i$$

$$= \sum E_i \delta A_i$$

$$= E \sum \delta A_i$$

$$= 2EA$$

$$\int \vec{E} \cdot d\vec{A}_i = E_i \cdot \Delta A_i$$

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

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

$$= 2EA'$$

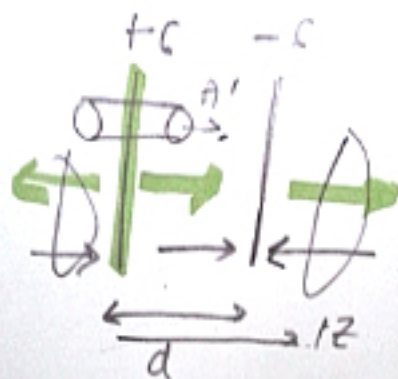
$$\phi = \frac{Q_{enc}}{\epsilon_0}$$

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



$$2EA' = \frac{\sigma A'}{\epsilon_0} \leftarrow \rightarrow$$

$$\vec{E} = \frac{\sigma}{2\epsilon_0} \left\{ \begin{array}{l} +z: \hat{z} \\ -z: -\hat{z} \end{array} \right\}$$



$$\oint \vec{E} \cdot d\vec{A} = EA' \quad \oint \vec{D} \cdot d\vec{A} = QA'$$

$$EA' = \frac{QA'}{\epsilon_0}$$

$$\vec{E} = \frac{Q}{\epsilon_0} \hat{z} \quad (\text{0 outside})$$