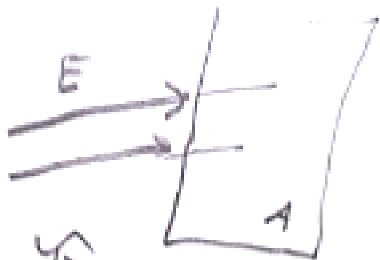


$$\Phi_E = \vec{E} \cdot \vec{A}$$

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

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

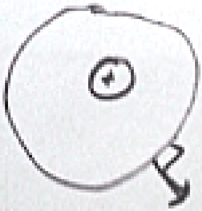
$$\boxed{\Phi_E = \frac{q_{enc}}{\varepsilon_0}}$$

encloser

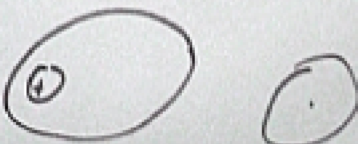
$$\Phi_E = \sum_{\Delta A_i} \vec{E}_i \cdot \Delta\vec{A}_i$$

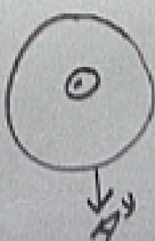
$$\Phi_E = \oint \vec{E} \cdot d\vec{A}_i$$

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



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





On GS:

E uniform,

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

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

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

E uniform

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

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

$$= E \oint\!\!\oint dA = 4\pi r^2 E$$

$$\Phi_E = \frac{Q_{enc}}{\varepsilon_0} \qquad Q_{enc} = Q$$

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

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

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

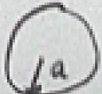
$$\Phi_E = \frac{Q_{enc}}{\varepsilon_0}$$

$Q_{enc} = ?$

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

---

(2)



Q

$$\rho = \frac{Q}{\frac{4}{3}\pi a^3} \qquad Q = \iiint_{v} \rho \, d^3r$$

$\Phi = q_{enc}/\varepsilon_0$

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

GS

on GS: E uniform

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

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

$= \oiint E\,dA$

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

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

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

$\oiint E \cdot dA$

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

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

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

Choose GS, centered on Q

$r \le a$

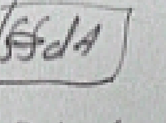
E unif.

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

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

$= \oiint E\,dA = E\boxed{\oiint dA}$

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



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

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

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

$\vec{E} = \frac{\rho}{\varepsilon_0}\frac{r}{3}\hat{r}$ || $\rho = \frac{Q}{\frac{4}{3}\pi a^3}$

433-17 (f)

$$\rho \;\; \llcorner \; 4\pi \int \rho \, r^2 \, dr$$

Spherical symmetry

$$\iiint f(r)\, d\vec{r} = 4\pi \int f(r) \cdot r^2 \, dr$$

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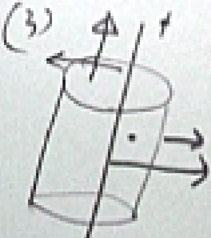
(3)



$$\lambda = \frac{Q}{\text{length}}$$

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

$$\Phi = \oiint \vec{E} \cdot d\vec{A}$$

$$= \oiint_{LSA} \vec{E} \cdot d\vec{A} + \oiint_{ENDS} \vec{E} \cdot d\vec{A}$$

Spherical symmetry

$$\iiint f(r)\, d\tau = 4\pi \int f(r) \cdot r^2\, dr$$

(3)

$$\lambda = \frac{Q}{\text{length } h} \qquad \Phi = \frac{Q_{enc}}{\varepsilon_0}$$

$$\Phi = \oiint \vec{E} \cdot d\vec{A}$$

$\downarrow 0$

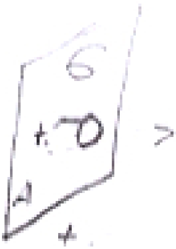
$$\oiint_{LSA} \vec{E} \cdot d\vec{A} = \oiint E\, dA = E \oiint dA$$

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

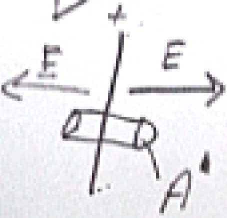
$$Q_{enc} = \lambda h$$

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

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



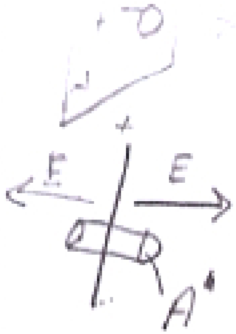
$$\sigma = \frac{Q}{\text{Area}}$$

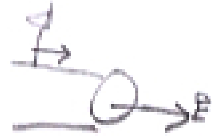


$$\Phi_E = \frac{Q_{enc}}{\varepsilon_0}$$

$$\Phi_E = \oint\!\!\oint \vec{E}\cdot d\vec{A} =$$

$$\underbrace{\oint\!\!\oint_{LSA} \vec{E}\cdot d\vec{A}}_{0} + \underbrace{\oint\!\!\oint_{ends} \vec{E}\cdot d\vec{A}}_{2E(A')}$$



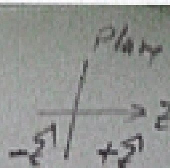


$$\oint \Phi_E = \frac{q_{enc}}{\varepsilon_0}$$

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

$$\underbrace{\oiint_{LSA} \vec{E}\cdot d\vec{A}}_{0} + \underbrace{\oiint_{ends} \vec{E}\cdot d\vec{A}}_{2E(A')}$$

$$q_{enc} = \sigma \cdot A'$$



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

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