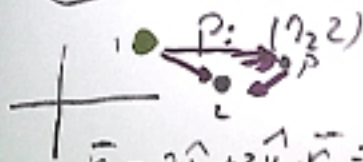


250
22

$$1: (+3\mu\text{C}; 2, 3)$$

$$2: (-3\mu\text{C}; 1, 5)$$



$$\vec{r}_1 = 2\hat{x} + 3\hat{y} \quad \vec{r}_2 = 1\hat{x} + 5\hat{y} \quad \vec{r}_P = 2\hat{x} + 2\hat{y}$$

$$\vec{r}_{1P} = 5\hat{x} - 1\hat{y} \quad \vec{r}_{2P} = 6\hat{x} - 3\hat{y}$$

$$\vec{E} = k\mu \left[\frac{32(5\hat{x} - 1\hat{y})}{[5^2 + 1^2]^{3/2}} + \frac{-3(6\hat{x} - 3\hat{y})}{[6^2 + 3^2]^{3/2}} \right]$$

$$= k\mu \left[\frac{10\hat{x} - 2\hat{y}}{[26]^{3/2}} - \frac{18\hat{x} - 9\hat{y}}{[45]^{3/2}} \right]$$

$$= k\mu \left[(-0.095\hat{x} - 0.059\hat{y}) + (-0.015\hat{x} + 0.029\hat{y}) \right]$$

$$= k\mu \left[-0.11\hat{x} - 0.03\hat{y} \right]$$

$$= 143\hat{x} + 126\hat{y} \frac{N}{C} \quad \vec{F} = q\vec{E}$$

Gauss's Law



A diagram showing a central point charge enclosed within a circular Gaussian surface. An arrow points from this diagram to the equation for electric flux.

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

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



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

$$\Phi_E = \oiint \vec{E} \cdot \hat{n} dA$$

$$Q_{enc} = \iiint \rho d\tau$$



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

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

$$= \oint E dA$$

$$= E \left[\oint dA \right]$$

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

$$Q_{\text{enc}} = q$$

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

$$E = \frac{q}{4\pi\epsilon_0 r^2} \rightarrow E = k \frac{q}{r^2}$$

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



Gauss's Law

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



① Choose GS

② on GS: $\vec{E} \parallel \vec{A}$

$$\vec{E} \cdot \vec{A} = EA; E \text{ uniform}$$

③ find $\oint \vec{E} \cdot d\vec{A}$

④ q_{enc}

$$\oint \vec{E} \cdot d\vec{A} = \oint E \cdot \vec{A} \quad q_{enc} = q$$

$$= \oint E dA \quad \text{⑤ Put this}$$

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

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

2



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

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

I: Choose GS

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

$$\begin{aligned}\oint \vec{E} \cdot d\vec{A} &= \oint \vec{E} \cdot \vec{A} = \oint E dA \\ &= E \oint dA = E(4\pi r^2)\end{aligned}$$

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

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



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

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

$$\textcircled{O} \quad \vec{E}(4\pi r^2) = \frac{Q_{\text{enc}}}{\epsilon_0}$$

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

$$Q_{\text{enc}} = \frac{Q}{\frac{4}{3}\pi a^3} \cdot \frac{4}{3}\pi r^3$$

$$= Q \cdot \left(\frac{r^3}{a^3}\right)$$

$$E(4\pi r^2) = \frac{Q}{\epsilon_0} \left(\frac{r^3}{a^3}\right) \Rightarrow \vec{E} = \frac{Q}{4\pi\epsilon_0} \frac{r}{a^3} \vec{r}$$



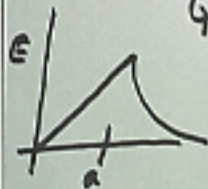
on G.S:
 E uniform, $\vec{E} \parallel \vec{A}$

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

$$\textcircled{O} \quad \vec{E} (4\pi r^2) = \frac{Q_{enc}}{\epsilon_0}$$

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

$$Q_{enc} = \frac{Q}{\left[\frac{4}{3}\pi a^3\right]} \cdot \left[\frac{4}{3}\pi r^3\right]$$



$$= Q \cdot \left(\frac{r^3}{a^3}\right)$$

$$\underline{E(4\pi r^2)} = \frac{Q}{\epsilon_0} \left(\frac{r^3}{a^3}\right) \Rightarrow \underline{\vec{E}} = \frac{Q}{4\pi\epsilon_0} \frac{r}{a^3} \vec{r}$$



outside:

$$E = \frac{\Phi_{enc}}{\epsilon_0}$$

$$\Phi_{enc} = 6 (4\pi R^2)$$

$$E(4\pi r^2) = \frac{6}{\epsilon} (4\pi a^2)$$

$$\underline{\text{out}} \quad E = \frac{6}{\epsilon_0} \frac{a^2}{r^2}$$

$$\text{In: } \Phi_{enc} = 0$$

$$\Rightarrow \oint \vec{E} \cdot d\vec{l} = 0$$

$$\Rightarrow \vec{E}_{in} = 0$$



outside:

$$E = \frac{\Phi_{enc}}{\epsilon_0}$$

$$\Phi_{enc} = 6 (4\pi R^2)$$

$$E(4\pi r^2) = \frac{6}{\epsilon} (4\pi a^2)$$

$$\underline{\text{out}} \quad E = \frac{6}{\epsilon_0} \frac{a^2}{r^2}$$

$$\text{In: } \Phi_{enc} = 0$$

$$\Rightarrow \oint \vec{E} = 0$$

$$\Rightarrow \vec{E}_{in} = 0$$