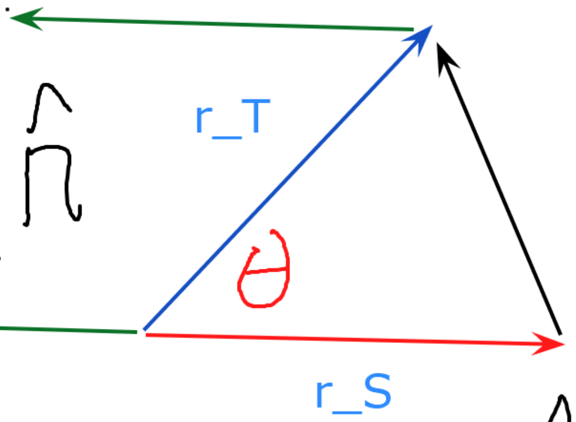
$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q_s}{\mathscr{r}^2}\hat{\mathscr{r}}$$



$\mathscr{r}$

$$\vec{\mathscr{r}} = \vec{r}_T - \vec{r}_S$$

$$\vec{\mathscr{r}};\ \mathscr{r},\ \hat{\mathscr{r}}$$

$$\hat{\mathscr{r}} = \frac{\vec{r}_T - \vec{r}_S}{\mathscr{r}}$$

A $\mathscr{r} = r_T - r_S$

B $(\vec{r}_T - \vec{r}_S) \times (\vec{r}_T - \vec{r}_S)$

C $(\vec{r}_T - \vec{r}_S) \cdot (\vec{r}_T - \vec{r}_S)$

D $\sqrt{r_T^2 + r_S^2 - 2 r_T r_S \cos\theta}$

$$\vec{r}_1 = 3\hat{x} + 2\hat{y} - \hat{z}$$

$$\vec{r}_2 = -\hat{x} - \hat{y} - 3\hat{z}$$

$$q_1 = 2nC$$

$$q_2 = 3nC$$

$$\vec{r}_T = \hat{x} + \hat{y} + \hat{z}$$

$$\vec{E}_T =$$

$$\vec{E} = \sum_i \frac{1}{4\pi\epsilon_0} \frac{dq_i}{\mathscr{r}_i^2} \hat{\mathscr{r}}_i \qquad \vec{E} =$$

$$\vec{\mathscr{r}}_1 = \vec{r}_T - \vec{r}_1$$

$$\vec{\mathscr{r}}_1 = \hat{x} + \hat{y} + \hat{z} - 3\hat{x} - 2\hat{y} + \hat{z}$$

$$\vec{\mathscr{r}}_1 = -2\hat{x} - \hat{y} + 2\hat{z}$$

$$\mathscr{r}_1 = \sqrt{4+1+4} = 3$$

$$\hat{\mathscr{r}}_1 = \frac{-2\hat{x} - \hat{y} + 2\hat{z}}{3}$$

$$\nabla = \frac{\partial}{\partial x}\hat{x} + \frac{\partial}{\partial y}\hat{y} + \frac{\partial}{\partial z}\hat{z}$$

Vector operator

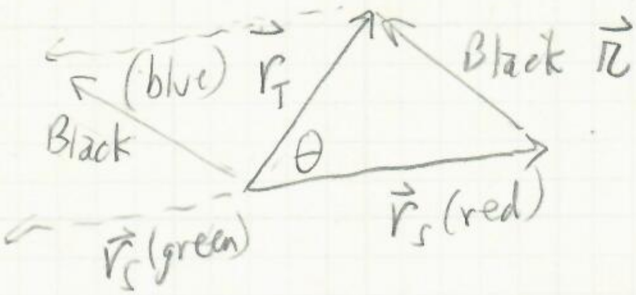
$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h} = \frac{df}{dx} \approx \frac{\Delta f}{\Delta x}$$

$$\nabla \cdot \vec{E} = \rho/\epsilon_0 \quad \left(\frac{\partial}{\partial x}\hat{x} + \frac{\partial}{\partial y}\hat{y} + \frac{\partial}{\partial z}\hat{z}\right) \cdot \left(E_x\hat{x} + E_y\hat{y} + E_z\hat{z}\right)$$

$$\operatorname{div}\vec{E} = \rho/\epsilon_0 \quad \frac{\partial E_x}{\partial x} + \frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z} = \rho/\epsilon_0 = \vec{\nabla} \cdot \vec{E}$$

$$\vec{F} = \frac{1}{4\pi\epsilon_0} \frac{q_T q_S}{\mathcal{R}^2} \hat{\mathcal{R}} \qquad \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9$$

$$\vec{\mathcal{R}} = \vec{r}_T - \vec{r}_s$$



$$\mathcal{R} = \left| \vec{r}_T - \vec{r}_s \right|$$

$\mathcal{R} = r_T - r_s$?   A

$\mathcal{R} = (\vec{r}_T - \vec{r}_s) \times (\vec{r}_T - \vec{r}_s)$?   B

$\mathcal{R} = (\vec{r}_T - \vec{r}_s) \cdot (\vec{r}_T - \vec{r}_s)$?   C

$\mathcal{R} = \sqrt{r_T^2 + r_s^2 - 2 r_T r_s \cos\theta}$?   D

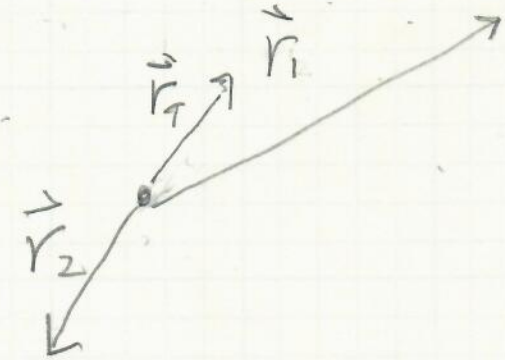
$$\hat{\mathcal{R}} = \frac{\vec{\mathcal{R}}}{\mathcal{R}}$$

$$\vec{F} = \frac{1}{4\pi\epsilon_0} \frac{qQ}{\mathcal{R}^2} \hat{\mathcal{R}} \qquad \text{Eq 2.1 Griffiths}$$

$$\vec{F} = Q\vec{E}$$

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{q \hat{\mathcal{R}}}{\mathcal{R}^2}$$

$$\vec{E} = \sum_i \frac{1}{4\pi\epsilon_0} \frac{q_i \hat{\mathcal{R}}_i}{\mathcal{R}^2}$$



$\vec{r}_1 = 3\hat{x} + 2\hat{y} - \hat{z}$

$\vec{r}_2 = -\hat{x} - \hat{y} - 3\hat{z}$

$q_1 = 2\,nC$

$q_2 = 3\,nC$

$\vec{r}_T = \hat{x} + \hat{y} + \hat{z}$

$E_T = ?$

$$\vec{F} = \frac{1}{4\pi\epsilon_0}\frac{qQ}{\mathscr{r}^2}\hat{\mathscr{r}}$$

$$\vec{E} \equiv \vec{F}/Q \text{ (for } Q \text{ infinitesimal)}$$

$$\vec{E} = \sum_i \frac{1}{4\pi\epsilon_0}\frac{q_i}{\mathscr{r}_i^2}\hat{\mathscr{r}}_i$$

$$\vec{\mathscr{r}}, \mathscr{r}, \hat{\mathscr{r}} \longrightarrow \mathscr{r} = |\vec{\mathscr{r}}| \quad \hat{\mathscr{r}} = \frac{\vec{\mathscr{r}}}{\mathscr{r}}$$

$$\vec{\mathscr{r}} = \vec{r}_T - \vec{r}_s$$

$$\vec{\mathscr{r}}_1 = \hat{x} + \hat{y} + \hat{z} - (3\hat{x} + 2\hat{y} - \hat{z}) = -2\hat{x} - \hat{y} + 2\hat{z}$$

$$\mathscr{r}_1 = \sqrt{2^2 + 1^2 + 2^2} = 3 \quad \hat{\mathscr{r}}_1 = \frac{-2\hat{x} - \hat{y} + 2\hat{z}}{3}$$

$$\vec{\mathscr{r}}_2 = \hat{x} + \hat{y} + \hat{z} - (-\hat{x} - \hat{y} - 3\hat{z})$$
$$= 2\hat{x} + 2\hat{y} + 4\hat{z}$$

$$\mathscr{r}_2 = \sqrt{4+4+16} = \sqrt{24} = 2\sqrt{6} \quad \mathscr{r}_2^2 = 24$$

$$\hat{\mathscr{r}}_2 = \frac{2\hat{x} + 2\hat{y} + 4\hat{z}}{2\sqrt{6}} = \frac{\hat{x} + \hat{y} + 2\hat{z}}{\sqrt{6}}$$

$$\vec{E}_T = \sum_i \frac{1}{4\pi\epsilon_0} \frac{q_i}{r_i^2} \hat{r}_i$$

$$\vec{E} = (8.99\times10^9)\left[\frac{q_1}{r_1^2}\hat{r}_1 + \frac{q_2}{r_2^2}\hat{r}_2\right]$$

$q_1 = 2\times10^{-9}\,C$

$q_2 = 3\times10^{-9}\,C$

$$\vec{E} = 8.99\left[\frac{2}{9}\cdot\left(\frac{-2\hat{x}-\hat{y}+2\hat{z}}{3}\right) + \frac{3}{24}\cdot\left(\frac{\hat{x}+\hat{y}+2\hat{z}}{\sqrt{6}}\right)\right]$$

$$\vec{E} = -1.33\hat{x} - 0.67\hat{y} + 1.33\hat{z} + 0.46\hat{x} + 0.46\hat{y} + 0.91\hat{z}$$

$$\vec{E} = -.87\hat{x} - 0.21\hat{y} + 2.24\hat{z}$$

"DEL DELIVERS"

HW Due Fri office Hrs 4-6 M/W 575-838-7113

Admission

Reading was 2.2 - Wed 2.1

Did lecture 5

$$\nabla = \frac{\partial}{\partial x}\hat{x} + \frac{\partial}{\partial y}\hat{y} + \frac{\partial}{\partial z}\hat{z}$$

scalar in Vector out $\vec{E} = -\nabla V$

$$= -\frac{\partial V}{\partial x}\hat{x} - \frac{\partial V}{\partial y}\hat{y} - \frac{\partial V}{\partial z}\hat{z}$$

Vector in, scalar out

$$\nabla \cdot \vec{E} = \rho/\epsilon_0 \qquad \rho = Q/\tau$$

$$\left(\frac{\partial}{\partial x}\hat{x} + \frac{\partial}{\partial y}\hat{y} + \frac{\partial}{\partial z}\hat{z}\right) \cdot \left(E_x\hat{x} + E_y\hat{y} + E_z\hat{z}\right)$$

$$\frac{\partial E_x}{\partial x} + \frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z} = \rho/\epsilon_0$$

$$\frac{1}{4\pi\epsilon_0}\frac{q}{r^2} = \vec{E} \qquad \vec{E} = \frac{\vec{F}}{q} = \frac{[N]}{[C]}$$

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

$$\frac{[C]}{[m^2]\frac{[N]}{[C]}} = \epsilon_0 = \frac{C^2}{N \cdot m^2} = \frac{C^2}{J \cdot m}; \quad \frac{1}{\epsilon_0} = \frac{N \cdot m^2}{C^2}$$

$$\frac{[N]}{[C][m]} = \rho\frac{[N]m^2}{[C^2]}$$

$$1 = \rho\frac{[m^3]}{[C]}$$

$$\nabla \cdot E \equiv \operatorname{div} \vec{E} \equiv \lim_{\tau \to 0} \frac{1}{\tau} \oint E \cdot da$$

Vector in Vector Out

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \rightarrow \nabla \times \vec{E} = 0 \quad \text{Electrostatics}$$

$$\operatorname{curl} E = \lim_{a \to 0} \frac{1}{a} \oint \vec{E} \cdot d\vec{l}$$

$$\nabla \times E = \left\| \begin{matrix} \hat{x} & \hat{y} & \hat{z} \\ \partial/\partial x & \cancel{\partial/\partial x} & \partial/\partial z \\ E_x & \cancel{E_y} & E_z \end{matrix} \right| = \hat{x} \frac{\partial E_z}{\partial y} - \frac{\partial E_y}{\partial z} + \hat{y}\left(\frac{\partial E_x}{\partial z} - \frac{\partial E_z}{\partial x}\right) + \hat{z}\left(\frac{\partial E_y}{\partial x} - \frac{\partial E_x}{\partial y}\right)$$

$$\nabla \cdot \vec{E} = \rho/\epsilon_0 \qquad \vec{E} = -\nabla V$$

$$\nabla \cdot \nabla V = \rho/\epsilon_0 \quad \text{Poisson's Eqn}$$

$$\left(\frac{\partial}{\partial x}\hat{x} + \frac{\partial}{\partial y}\hat{y} + \frac{\partial}{\partial z}\hat{z}\right) \cdot \left(\frac{\partial}{\partial x}\hat{x} + \frac{\partial}{\partial x}\hat{y} + \frac{\partial}{\partial z}\hat{z}\right) V$$

$$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = \rho/\epsilon_0 \quad \text{"del-squared"}$$

$$\nabla^2 V = \rho/\epsilon_0 \quad \text{or} \quad = 0 \quad \text{no free charge}$$