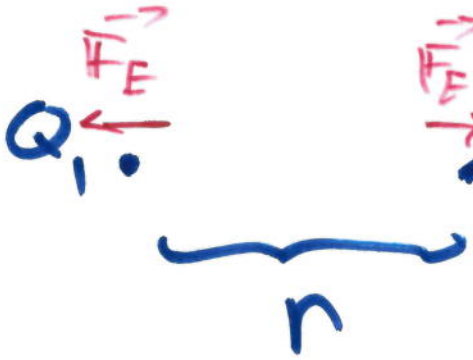
Physics 201 Day 2

1. The Electric Field
2. Adding vectors
3. Voltage and Electric Field

Last Time: $F_E = k\frac{|Q_1 Q_2|}{r^2}$



The electric field

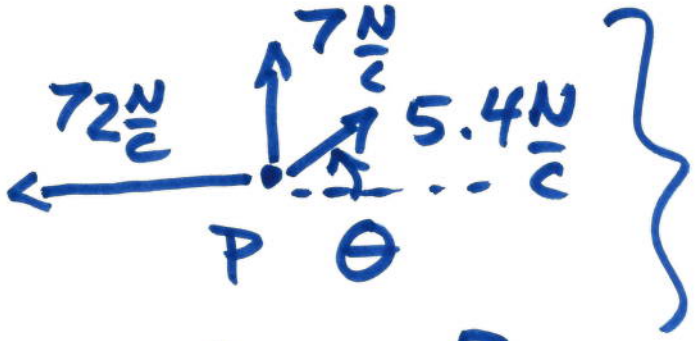
$q'\vec{E} = \vec{F}$ ← on charge q' at P

↑ at empty point P

$$E_7 = \frac{k\,7nC}{(3m)^2} = 9\times10^9 \frac{Nm^2}{C^2}\cdot\frac{7\times10^{-9}\,C}{9m^2}$$

$$= 7\,\frac{N}{C}$$

$$E_8 = \frac{9\times10^9 \frac{Nm^2}{C^2}\times 8\times10^{-9}\,C}{(1m)^2} = 72\,\frac{N}{C}$$



Now add the vectors.

$\vec{E}$ will have E_x and E_y

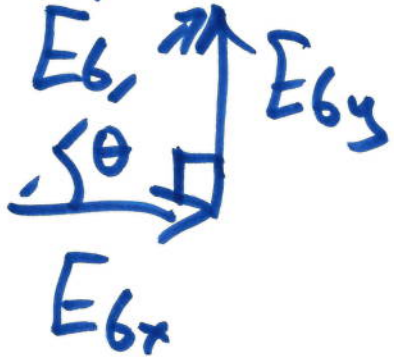
$$\tan\theta = \frac{opp}{adj} = \frac{3}{1} \qquad \theta = \tan^{-1}(3)$$

$$= 71.6^\circ$$

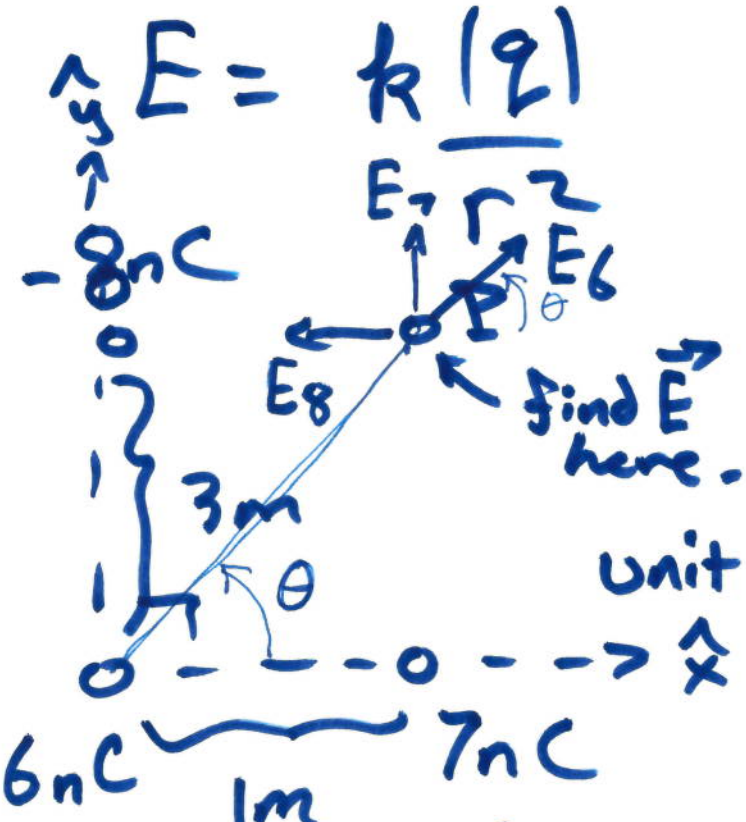
break E_6 into x, y components.

$$E_{6x} = E_6\cos\theta$$

$$E_{6y} = E_6\sin\theta$$



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



$1nC = 10^{-9} C$

$\vec{E}$ points away from $+q$ toward $-q$.

unit of E is $\frac{N}{C} = \frac{V}{m}$

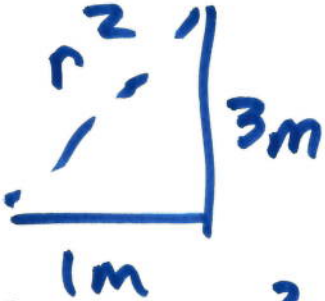
Newton per coulomb (Volt per meter)

$E_6 = \frac{k|q|}{r^2}$

$k = 9\times10^9 \frac{Nm^2}{C^2} = \frac{1}{4\pi\epsilon_0}$

$= 9\times10^9 \frac{Nm^2}{C^2} \cdot \frac{6\times10^{-9} C}{10m^2}$

$= 5.4 \frac{N}{C}$



$r^2 = (1m)^2 + (3m)^2$

$= 1m^2 + 9m^2$

$r^2 = 10 m^2$

$$E_{6x} = 5.4 \frac{N}{C} \cdot \cos(71.6^\circ)$$

$$= 1.71 \frac{N}{C}$$

$$E_{6y} = 5.12 \frac{N}{C}$$

$$E_{y\,(tot)} = E_{6y} + E_7 =$$

$$= 5.12 \frac{N}{C} + 7 \frac{N}{C} = 12.12 \frac{N}{C}$$

$$E_{x\,(tot)} = E_{6x} - E_8$$

$$\cancel{5.12} \frac{N}{C} - 72 \frac{N}{C}$$

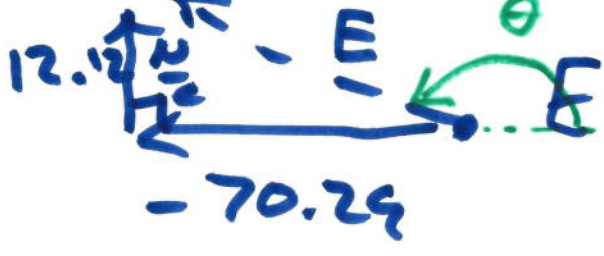
$$1.71$$

$$= -70.29 \frac{N}{C}$$

$$\vec{E} = (\underbrace{-70.29}_{x}, \underbrace{12.12}_{y}) \frac{N}{C}$$

$$= (-70.29\,\hat{x} + 12.12\,\hat{y}) \frac{N}{C}$$

Can convert $\vec{E}$ to polar form:



$$E^2 = (70.29)^2 + (12.12)^2$$

in units of $\frac{N}{C}$

$E = 71.3 \frac{N}{C}$

angle for $\vec{E}$?

$\theta = \tan^{-1}\left(\frac{E_y}{E_x}\right)$ sort of.

$= \tan^{-1}\left(\frac{12.12}{-70.29}\right) = \tan^{-1}(-0.1724)$

$= -9.78°$

If x-comp. is < 0, add $180°$ to get right answer!

$170.22° = \theta$

$\vec{E} = \left(71.3 \frac{N}{C}, 170.22°\right)$ Polar

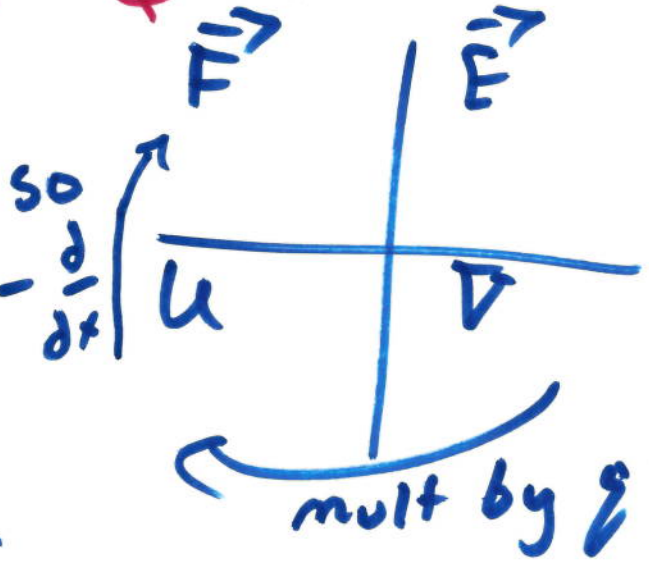
$\vec{F}_E$	$\vec{E}$ } vectors
U_E potential energy	V voltage } scalars
Pairs of charges	anywhere (empty)

Warning: People call V "the potential" aka the electrostatic potential the scalar potential sometimes symbol ϕ is used.

$$\vec{F}_E = q' \vec{E}$$

and

$$U_E = q' V$$



$$F_x = -\frac{dU}{dx} \qquad \vec{F} = -\nabla U$$

$$E_x = -\frac{dV}{dx} \qquad \vec{E} = -\nabla V$$

divide out q'

in reverse:

$$\Delta U = -\int_{path} \vec{F} \cdot d\vec{x} \qquad \Delta V = -\int_{path} \vec{E} \cdot d\vec{x}$$