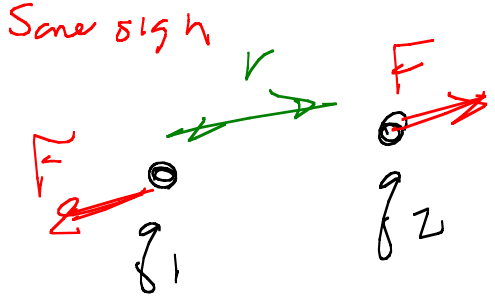
Phys 2120-4 8/29/12

Note Title 8/29/2012

Ch 20 $\vec{E}$ fields

Coulombs

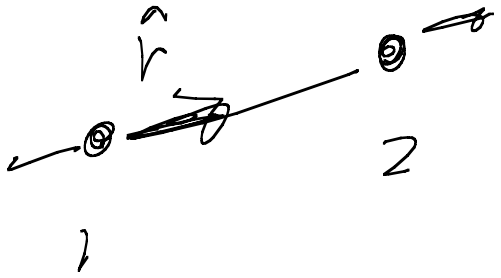


Coulomb's Law

$$|\vec{F}| = k\left|\frac{q_1 q_2}{r^2}\right| \qquad k = \frac{1}{4\pi\epsilon_0}$$

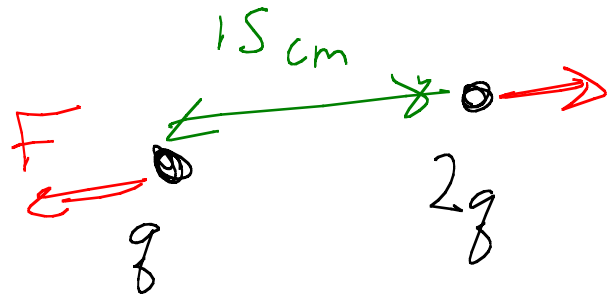
$$\vec{F}_{1 \text{ on } 2} = k\frac{q_1 q_2}{r^2}\hat{r}$$

$$k = 9.0\times10^9 \frac{Nm^2}{C^2}$$



20.37 Two charges one twice as large as the other are located 15 cm apart, experience rep. force 95 N. Magnitude of larger charge

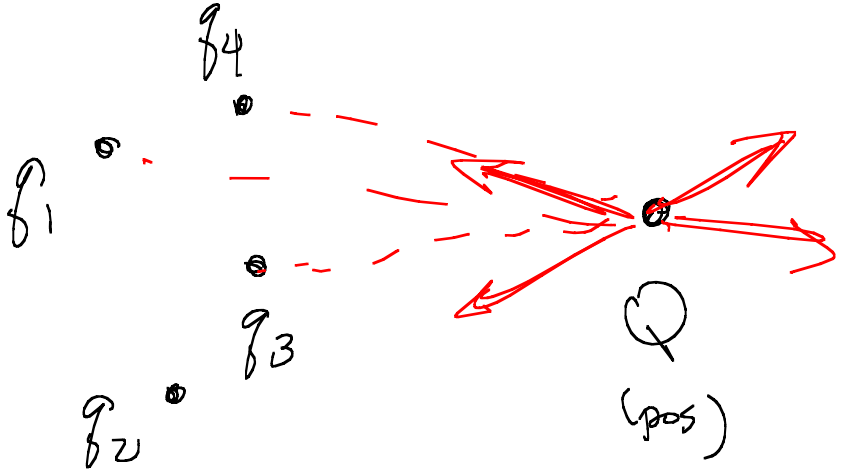
$$F = k\left|\frac{q\,2q}{r^2}\right|$$



$$q^2 = \frac{r^2 f}{2k} = \frac{(0.15\,m)^2(95\,N)}{2\left(9.0\times10^9\,\frac{N m^2}{C^2}\right)} = 1.19\times10^{-10}\,C^2$$

$$q = \pm 1.1 \times 10^{5}\,C$$

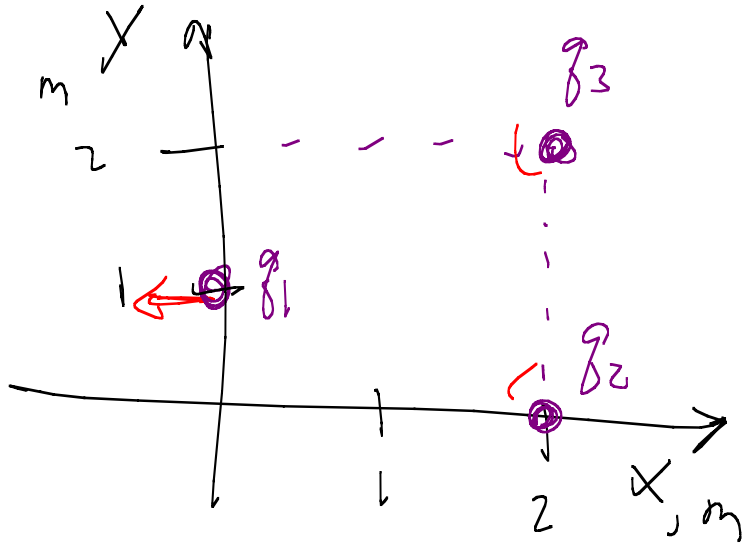
Larger: $2q = \boxed{2.2 \times 10^{5}\,C}$



Add forces vectorially

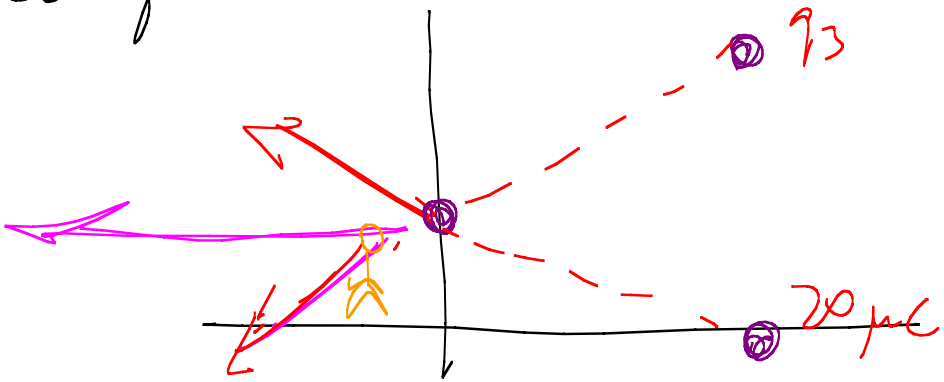
20.43 $q_1 = 25\ \mu C$

$q_2 = 20\ \mu C$



If the force on q_1 points in the $-x$ direction,

find a) q_3 b) Magnitude of force on q_1



q_3 is positive

q_3 & q_2 same distance $q_3 = q_2$

$q_3 = q_2 = 20\ \mu C$

$\tan\theta = 0.5$

$\theta = 26.6°$

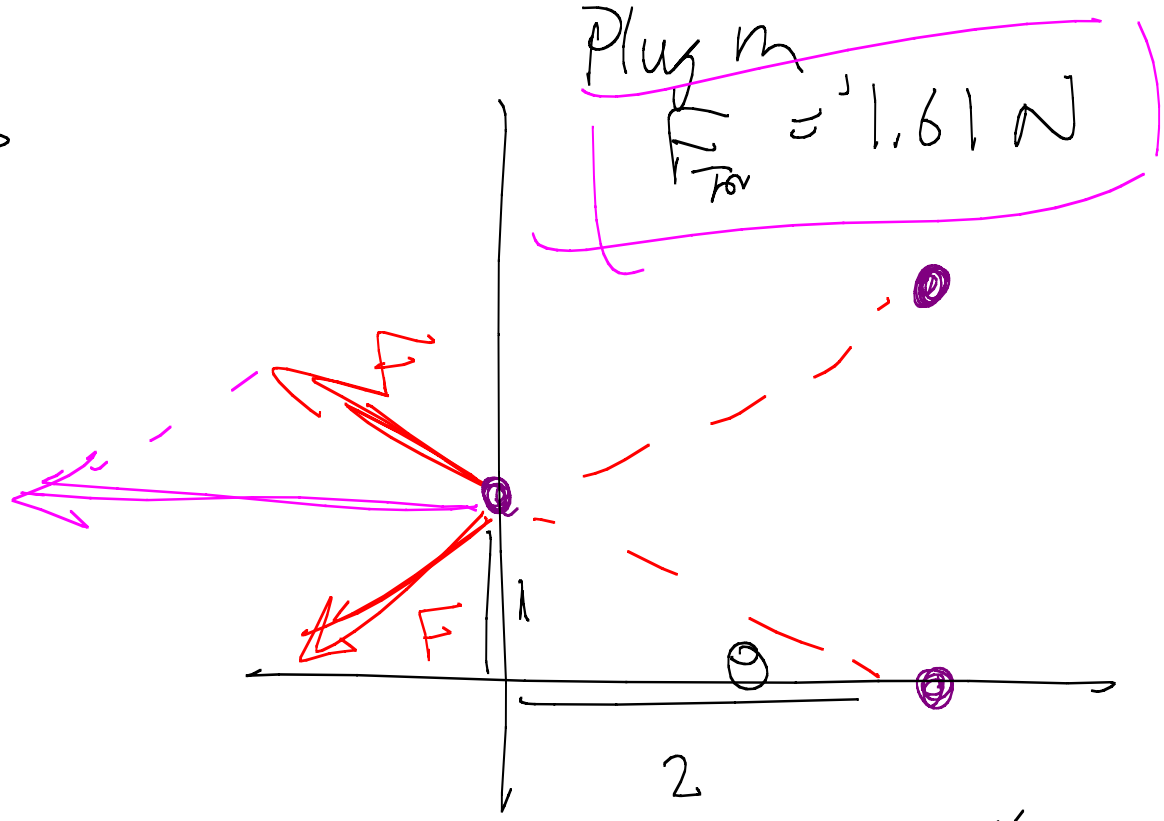
Mag of total force

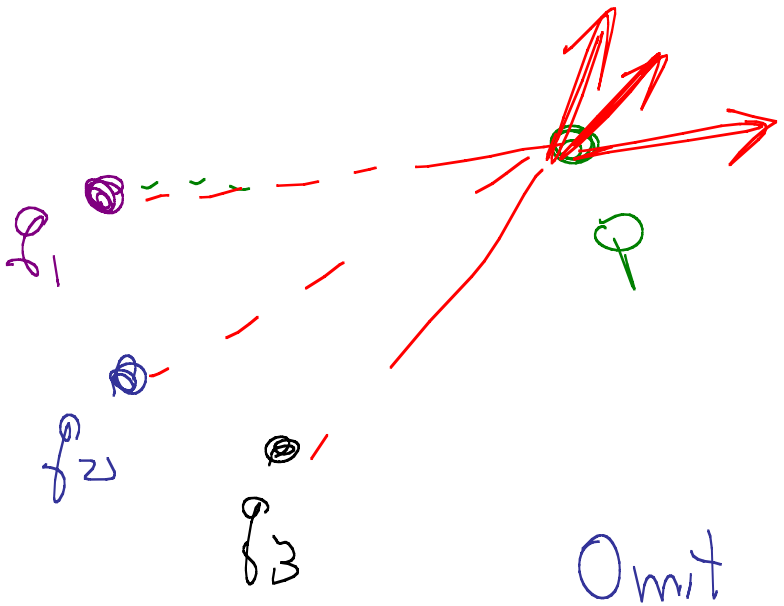
$F = 2F\cos\theta$

$F = k\frac{q_1 q_3}{r^2} = \left(9.0\times10^9 \frac{N m^2}{C^2}\right)\frac{(25\times10^{-6}C)(20\times10^{-6}C)}{(5m)^2}$

Plug in

$F_{Tot} = 1.61\ N$





$k \frac{q}{r_1^2}$

$k \frac{q}{r_2^2}$

Vectors

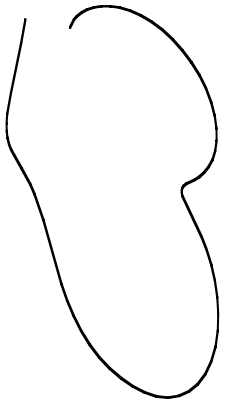
Omit the q, add vectors, mult. by q

Calc something so that in end, mult by q to get force.

Force / unit chge at location of interest.

Force/charge

$\vec{E} = \vec{F}/q \qquad \vec{F} = q\vec{E}$

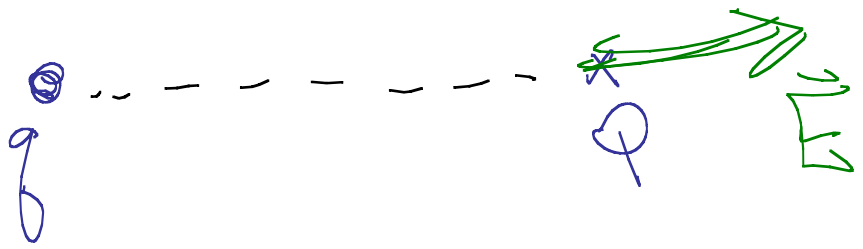


$\vec{F}/Q = \vec{E}$ electric field

Electric field is a vector

Units?
Units?

$\frac{\text{Newtons}}{\text{Coulomb}} = \frac{\text{Volt}}{\text{m}}$



What is elec field due to point charge q

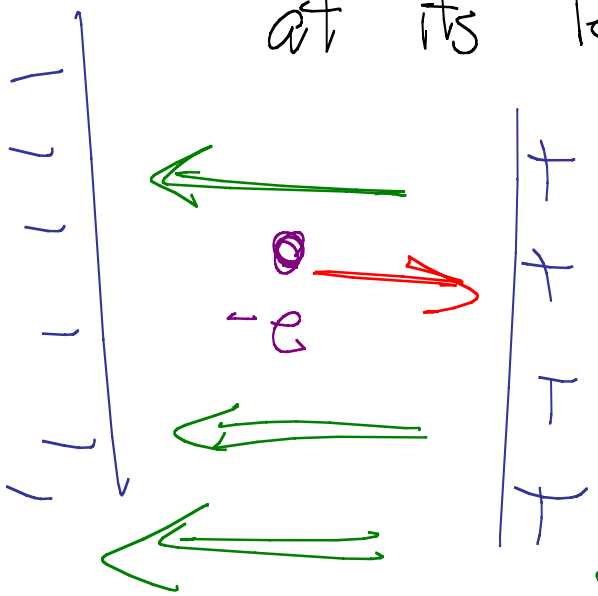
If q positive points away from charge

q neg point toward charge.

q pos

mag. $|\vec{E}| = k\left|\frac{q}{r^2}\right|$

20.21 An electron experiences an electric force of 0.61 nN. What's the field strength at its location?

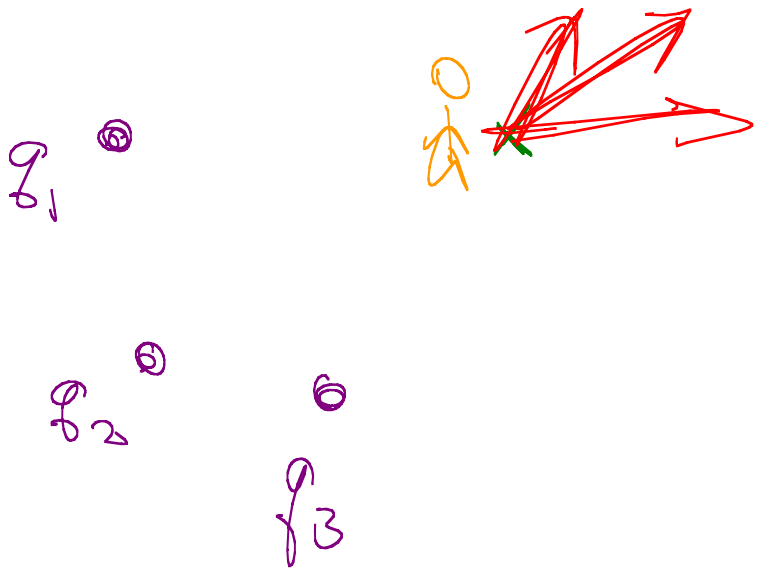


$$\vec{F} = q\vec{E}$$

Magnitude

$$F = eE$$

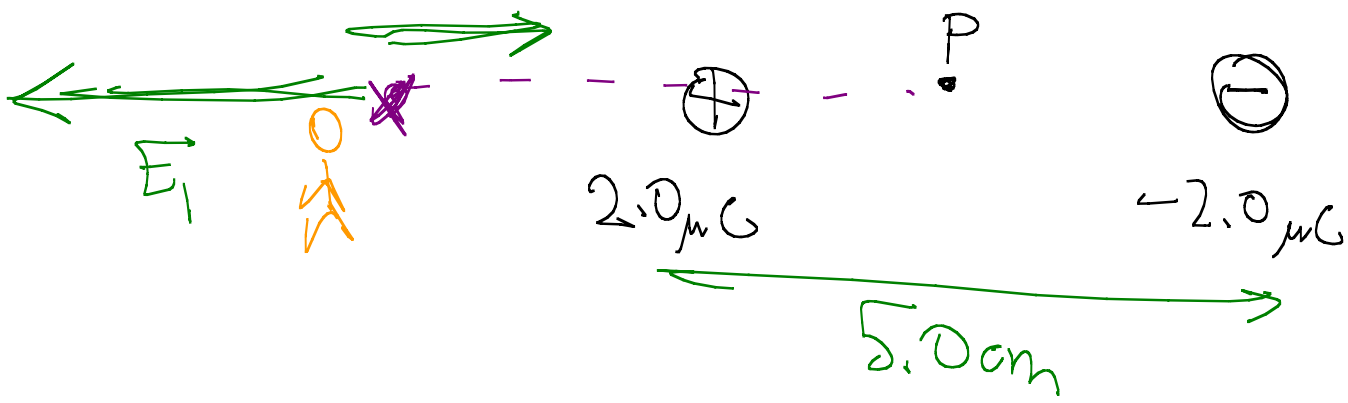
$$E = \frac{F}{e} = \frac{(0.61\times10^{-9}\ N)}{(1.6\times10^{-19}\ C)} = 3.8\times10^{9}\ \frac{N}{C}$$



$$\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3$$

$$|\vec{E}| = k\frac{q_i}{r_i^2}$$

20.27 In the figure, point P is midway between two charges. Find $\vec{E}$ field in plane of the page a) 5.0 cm to left of P



$$E_{x_{Total}} = -k\frac{(2.0\times10^{-6}C)}{(2.5\times10^{-2}m)^2} + k\frac{(2.0\times10^{-6}C)}{(7.5\times10^{-2}m)^2}\ \hat{i}$$

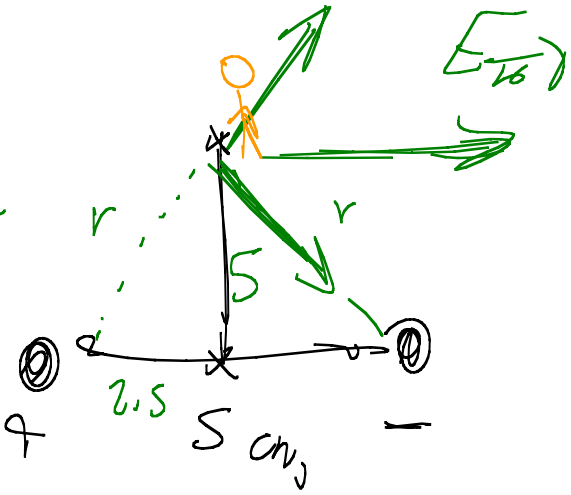
$$= -2.56\times10^{7}\ \frac{N}{C}\ \hat{i}$$

b) 5.0 cm directly above P

$|\vec{E}|$ from each $= k\frac{q}{r^2} = 5.76\times10^{6}\frac{N}{C}$

$r = 5.59\ cm$

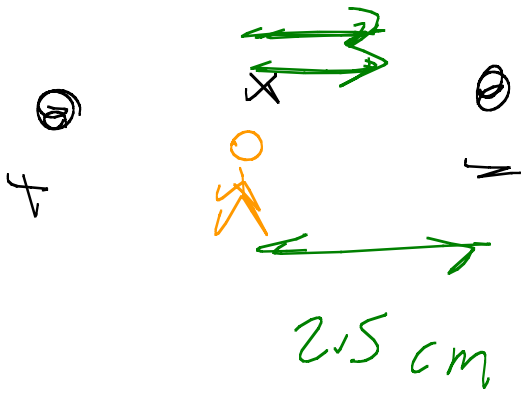
$\vec{E}_{net} = +5.7\times10^{6}\frac{N}{C}\ \hat{i}$

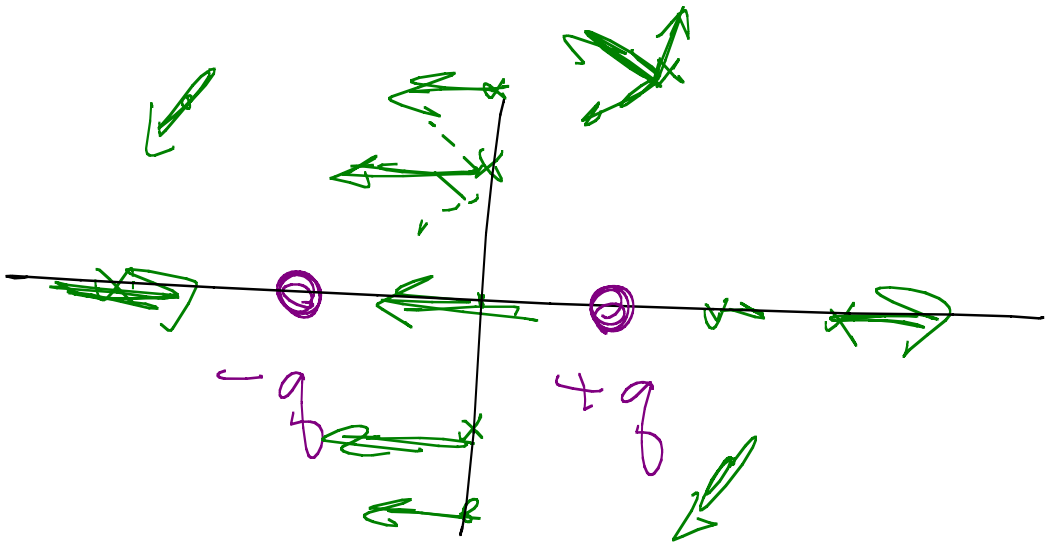


c) At P

$$\vec{E}_{tot} = 2k\frac{|q|}{(2.5\times10^{-2}\,m)^2}$$

$$\approx 5.8\times10^{7}\,\frac{N}{C}\,\hat{i}$$





Dipole