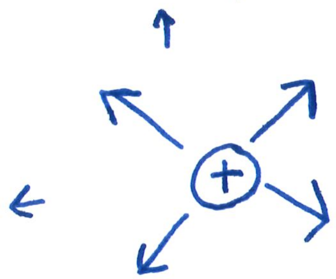
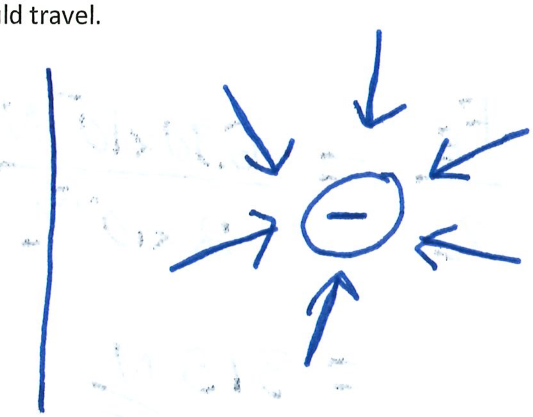
Electric Fields

Surrounding any charge there is an electric field. We define the direction the vectors point to be the direction a positive charge would travel.





The strength of an electric field is determined by the distance from the change and the magnitude of the charge.

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

in N/C

$k = 8.988 \times 10^9 \frac{N \cdot m^2}{C^2}$

q = charge in C

r = distance from charge

Another way to think of the field strength is as force per unit of charge

$$E = \frac{F_E}{q}$$

* Remember $F_g = mg$ and $g = \frac{F_g}{m}$

Example: What is the electric field strength at a point where a -2.00 μC charge experiences an electric force of 6.30x10^{-4} N?

$$E = \frac{F_E}{q} = \frac{6.30\times10^{-4} N}{2\times10^{-6} C}$$

$$= 315 \, N/C$$

Example: At a distance of 0.75m from a small charged object the electric field strength is 2.10x10^{4} N/C. At what distance from this same object would the electric field strength be 4.50x10^{4} N/C?

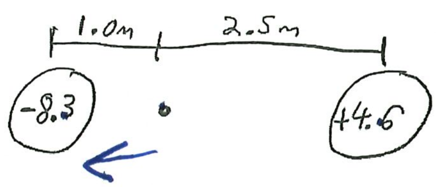
$$E = \frac{kq}{r^2} \rightarrow \frac{E \times r^2}{k} = q \rightarrow 1.312\times10^{-6}$$

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

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

$$r = \sqrt{\frac{kq}{E}} = 0.51 m$$

Example: What is the strength and direction of the electric field 1.0 metres right from a $-8.3\ \mu C$ charge and 2.5 metres left from a $+4.6\ \mu C$ charge as shown?

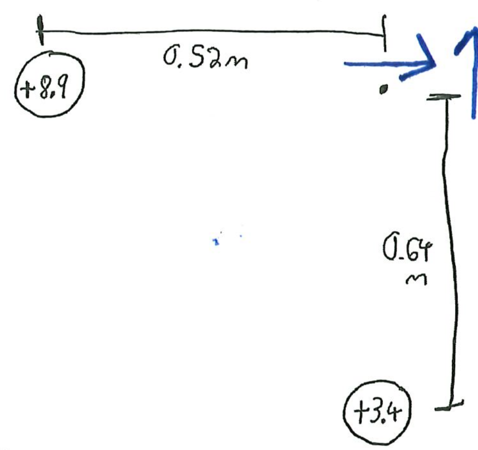


From $-8.3\mu C = \frac{k\ 8.3\times10^{-6}}{(1.0)^2} = 74683.4\ \frac{N}{C}$ ←

From $4.6\mu C = \frac{k \cdot 4.6\times10^{-6}}{(2.5)^2} = 6622.5\ \frac{N}{C}$

Total: $74683.4\frac{N}{C} + 6622.5\frac{N}{C} = 81000\frac{N}{C}$ towards $-8.3\mu C$ charge

Example: What is the strength and direction of the electric field at a point if there is a $+3.4\ \mu C$ charge 0.64 metres to the South and a $+8.9\ \mu C$ charge 0.52 metres to the East.

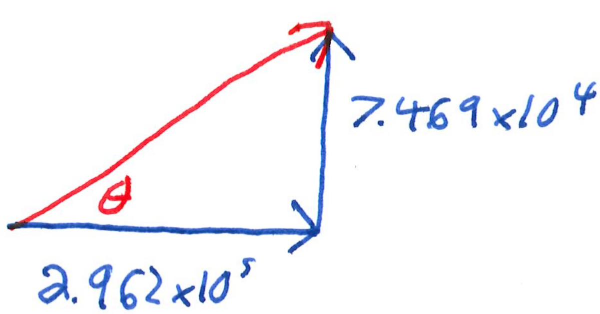


$\rightarrow = \frac{(k)(8.9\times10^{-6})}{0.52^2}$

$= 2.962\times10^5\ N/C$

$\uparrow = \frac{(k)(3.4\times10^{-6})}{0.64^2}$

$= 7.469\times10^4\ N/C$



$\sqrt{(7.469\times10^4)^2 + (2.962\times10^5)^2}$

$= 3.1\times10^5\ \frac{N}{C}$

$\tan^{-1}\left(\frac{7.469\times10^4}{2.962\times10^5}\right)$

$= 14°$ North of East

Electric Potential Energy

Electric potential energy is analogous to ______________________ potential energy. It is the amount of energy a charged object has by virtue of being in an electric field, that energy can be converted into ______________________ energy if the object is left to accelerate.

Recall the formula for gravitational potential energy in a non uniform field was

The formula for electric potential energy in a non uniform field is

The zero point is when the two objects are ________________ far apart.

Example: How much work must be done to bring a 4.0 uC charged object to within 1.0 m of a 6.0 uC charged object from a long way away?

In this case, bringing a positive charge near another positive charge requires ____________ therefore the work is __________________.