What is the electric field at a location $\vec{b}$ = <-0.2, -0.3, 0> m, due to a particle with charge +4 nC located at the origin?

$\vec{E}$ = [ ] N/C

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{q}{|\vec{r}|^2} \hat{r}$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{4q}{|\vec{r}|^2} \frac{\vec{r}}{|\vec{r}|}$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{q\vec{r}}{|\vec{r}|^3}$$

nC conversion

$$q = 4 \cdot 1e-9$$

$$= \langle -153.609, -230.414, 0 \rangle \frac{N}{C}$$

You want to create an electric field $\vec{E}$ = < 0, 2 × 10^4, 0> N/C at location < 0, 0, 0>.

Where would you place a proton to produce this field at the origin?

$\vec{r}_p$ = [ ] m

Instead of a proton, where would you place an electron to produce this field at the origin?

$\vec{r}_e$ = [ ] m

Part One

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{q\vec{r}}{|\vec{r}|^3}$$

$$\vec{E}_y = \frac{1}{4\pi\varepsilon_0} \frac{q\cancel{\vec{r}}_y}{\vec{r}_y^{\cancel{3}\,2}}$$

$$\vec{E}_y = \frac{1}{4\pi\varepsilon_0} \frac{q}{\vec{r}_y^{\,2}}$$

$$\frac{1}{\vec{r}_y^{\,2}} = \frac{\vec{E}_y}{q} \frac{1}{\frac{1}{4\pi\varepsilon_0}}$$

$$\vec{r}_y = \sqrt{\frac{q}{\vec{E}_y} \frac{1}{4\pi\varepsilon_0}}$$

$$\vec{r}_y = -\vec{r}_p$$

$$\vec{r}_p = -\sqrt{\frac{q}{\vec{E}_y}\frac{1}{4\pi\varepsilon_0}}$$

$$= \langle 0, -2.68e{-7}, 0 \rangle m$$

Part Two

$$\vec{r}_e = \langle 0, 2.68e{-7}, 0 \rangle m$$

A $\pi-$ ("pi-minus") particle, which has charge $-e$, is at location $<$ 4.00 × 10^{-9}, -4.00 × 10^{-9}, -3.00 × 10^{-9} $>$ m. What is the electric field at location $<$ -3.00 × 10^{-9}, 5.00 × 10^{-9}, 4.00 × 10^{-9} $>$ m, due to the $\pi-$ particle?

$\vec{E}$ = ______ ---Select---

An antiproton (same mass as the proton, charge $-e$) is at the observation location. What is the force on the antiproton, due to the $\pi-$?

$\vec{F}$ = ______ ---Select---

Part One

obs = Observation point

$$\vec{r}_{e\ to\ obs} = \vec{r}_{obs} - \vec{r}_{particle}$$

$$= \langle -7e{-9}, 9e{-9}, 7e{-9} \rangle m$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{-q\,\vec{r}_{e\ to\ obs}}{|\vec{r}_{e\ to\ obs}|^3}$$

$$= \langle 4.21e6, -5.41e6, -4.21e6 \rangle \frac{N}{C}$$

Part Three

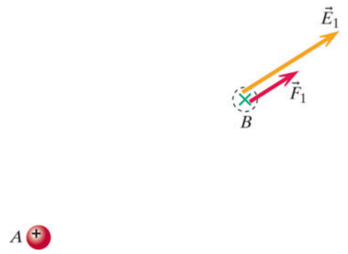
$$\vec{E} = \frac{\vec{F}}{q}$$

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

$= \langle -6.73e{-13}, 8.66e{-13}, 6.73e{-13} \rangle$ N

Lithium nucleus affected by an electric field

A proton at location *A* makes an electric field $\vec{E}_1$ at location *B*. A different proton, placed at location *B*, experiences a force $\vec{F}_1$.



If $|\vec{E}_1|$ = 400 N/C, what is $|\vec{F}_1|$?

$|\vec{F}_1|$ = ____ N

Now the proton at *B* is removed and replaced by a lithium nucleus, containing three protons and four neutrons. The proton at location *A* remains in place.
What is the magnitude of the electric force on the lithium nucleus?

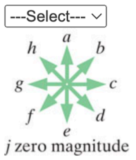
$|\vec{F}_{\text{on Li}}|$ = ____ N

Now the Lithium nucleus is removed, and an electron is placed at location *B*. The proton at location *A* remains in place. What is the magnitude of the electric force on the electron?

$|\vec{F}_{\text{on e}^-}|$ = ____ N

Which arrow below best indicates the direction of the force on the electron due to the electric field?

---Select---



Part One

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

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

$= 6.4e{-17}$ N

Part Two

$|\vec{F}| = |\vec{E}|3q$

$= 1.92e{-16}$ N

Part Three and Four

Same as Part One and the direction of force is ↙