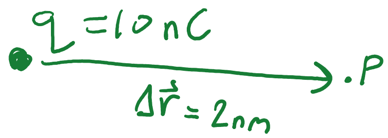
Electric Fields Fundamental Solutions

Saturday, May 12, 2018 8:37 PM

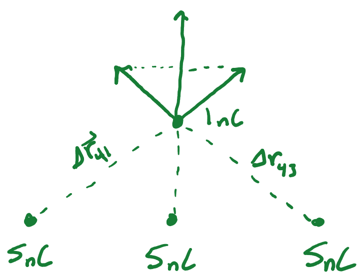
(1)



$$|\vec{E}| = k\frac{q}{|\Delta\vec{r}|^2} = 9\times10^9\,\frac{10\times10^{-9}}{(2\times10^{-9})^2}$$

$$|\vec{E}| = 4.5\times10^{19}\,\frac{N}{C}$$

(2)



$$\Delta\vec{r}_{41} = \langle 2\times10^{-9},\ 2\times10^{-9}\rangle$$

$$|\Delta\vec{r}_{41}| = \sqrt{4\times10^{-18}+4\times10^{-18}}$$

$$= 2\sqrt{2}\times10^{-9}$$

$$\Delta\hat{r}_{41} = \langle \tfrac{1}{\sqrt{2}},\ \tfrac{1}{\sqrt{2}}\rangle$$

$$\Delta\hat{r}_{43} = \langle -\tfrac{1}{\sqrt{2}},\ \tfrac{1}{\sqrt{2}}\rangle$$

$$\vec{F}_{41} = k\frac{q_4 q_1}{|\Delta\vec{r}_{41}|^2}\,\Delta\hat{r}_{41}$$

$$= (9\times10^9)\frac{(5\times10^{-9})(10^{-9})}{8\times10^{-18}}\langle \tfrac{1}{\sqrt{2}},\tfrac{1}{\sqrt{2}}\rangle$$

$$= 5.625\times10^9\langle \tfrac{1}{\sqrt{2}},\tfrac{1}{\sqrt{2}}\rangle\ N$$

$$\vec{F}_{43} = 5.625\times10^9\langle -\tfrac{1}{\sqrt{2}},\tfrac{1}{\sqrt{2}}\rangle$$

$$\vec{F}_{42} - (9\times10^9)\frac{(5\times10^{-9})(10^{-9})}{4\times10^{-18}}\langle 0,1\rangle$$

$$= 1.125\times10^{10}\langle 0,1\rangle\ N$$

$$\vec{F}_{net} = \vec{F}_{41}+\vec{F}_{42}+\vec{F}_{43}$$

$$= \left\langle \frac{5.625\times10^9}{\sqrt{2}},\ \frac{5.625\times10^9}{\sqrt{2}}\right\rangle + \left\langle -\frac{5.625\times10^9}{\sqrt{2}},\ \frac{5.625\times10^9}{\sqrt{2}}\right\rangle$$

$$+\langle 0,\ 1.125\times10^{10}\rangle$$

$$= \langle 0,\ 1.92\times10^{10}\rangle$$

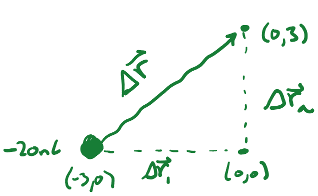
$$\vec{F}_{net} = 1.92\times10^{10}\,N\ \langle 0,1\rangle$$

a) 1.92×10^{10} N

b) up

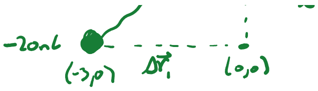
c) down

(3)



$$\vec{E}_1 = k\frac{q}{|\Delta\vec{r}|^2}\,\Delta\hat{r}$$

$$= (9\times10^9)\frac{(-20\times10^{-9})}{18\times10^{-18}}\langle \tfrac{1}{\sqrt{2}},\tfrac{1}{\sqrt{2}}\rangle$$



$\Delta\vec{r} = -\Delta\vec{r}_1 + \Delta\vec{r}_a$

$= \langle 3, 3\rangle$ nm

$|\Delta\vec{r}| = \sqrt{(3\times10^{-9})^2 + (3\times10^{-9})^2}$

$= 3\sqrt{2}\times10^{-9}$

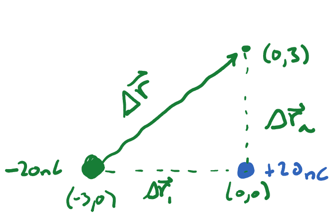
$\Delta\hat{r} = \langle \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\rangle$

$= (9\times10^{9})\frac{\quad}{18\times10^{-18}}\langle \frac{}{\sqrt{2}}, \frac{}{\sqrt{2}}\rangle$

$= -10^{19}\langle \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\rangle$

$\boxed{\text{a) } |\vec{E}_1| = 10^{19}\ \frac{N}{C}}$

b)



$\Delta\vec{r}_2 = \Delta\vec{r}_a = \langle 0, 3\rangle$ nm

$|\Delta\vec{r}_2| = 3$ nm

$\Delta\hat{r}_2 = \langle 0, 1\rangle$

$\vec{E}_{new} = \vec{E}_1 + \vec{E}_2$

$\vec{E}_2 = k\frac{q_2}{|\Delta\vec{r}_2|^2}\Delta\hat{r}_2$

$= (9\times10^{9})\frac{20\times10^{-9}}{9\times10^{-18}}\langle 0, 1\rangle$

$\vec{E}_2 = 2\times10^{19}\langle 0, 1\rangle\ \frac{N}{C}$

$\vec{E}_{new} = \langle \frac{-10^{19}}{\sqrt{2}}, \frac{-10^{19}}{\sqrt{2}}\rangle + \langle 0, 2\times10^{19}\rangle$

$= \langle \frac{-10^{19}}{\sqrt{2}}, (2-\frac{1}{\sqrt{2}})\times10^{19}\rangle\ \frac{N}{C}$

$|\vec{E}_{new}| = 1.47\times10^{19}\ \frac{N}{C}$

$\frac{|E_{new}|}{|E_1|} = 1.47$

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

$\vec{F} = (-10^{-9})\,10^{19}\langle -\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}\rangle$

$\boxed{\vec{F} = 10^{10}\langle \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\rangle}$

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

$|\vec{F}| = (-10^{-9})(1.47\times10^{19})$

$|\vec{F}| = 1.47\times10^{10}$ N

$\Delta\hat{r} = \langle \frac{-\frac{1}{\sqrt{2}}10^{19}}{1.47\times10^{19}}, \frac{(2-\frac{1}{\sqrt{2}})10^{19}}{1.47\times10^{19}}\rangle$

$= \langle -0.48, 0.88\rangle$

$\vec{F} = 1.47\times10^{10}\text{ N}\ \langle +0.48, -0.88\rangle$

q = -

d) $\vec{F} = k\frac{qq}{|\Delta\vec{r}|^2}\Delta\hat{r}$

$= 9\times10^{9}\frac{(20\times10^{-9})(-10^{-9})}{(3\times10^{-9})^2}\langle 0, 1\rangle$

$\boxed{\vec{F} = 2\times10^{10}\text{ N}\ \langle 0, 1\rangle}$