4.

$$E_T = E_1 + E_2$$

$$E_1 = \frac{kQ^2}{r^2} = \frac{(9\times 10^9)(2\times 10^{-7})}{(.075)^2}$$

$$E_1 = 3.2\times 10^5\ \frac{n}{C}$$

$$E_2 = 3.2\times 10^5\ \frac{n}{C}$$

$$E_T = 6.4\times 10^5\ \frac{n}{C}$$

The E – field points at the negative charge.

7. Starting at the top left and going clockwise, label the charges 1,2,3, and 4. This will correspond to the subscripts.

Center is equidistant from vertices.

$$\text{Distant} = \frac{\sqrt{2}a}{2}$$

Regarding magnitudes :

$$E_1 = \frac{kq}{\left(\frac{\sqrt{2}a}{2}\right)^2} = \frac{2kq}{a^2}$$

$$E_2 = \frac{2k(2q)}{a^2} = 2E_1$$

$$E_3 = 2E_1$$

$$E_4 = E_1$$

$$E_T = 2E_1\cos(45^\circ)$$

$$E_T = 2\left(\frac{(9\times 10^9)(10^{-8})}{\left(\frac{\sqrt{2}(.05)}{2}\right)^2}\right)\left(\frac{\sqrt{2}}{2}\right)$$

$$E_T = 1.02\times 10^5\ \frac{n}{C}$$

]

11.

Let x be the distance from the positive charge.

$$E_1 + E_2 = 0 \Rightarrow E_1 = -E_2$$

$$E_1 = \frac{kq_1}{x^2} = -E_2 = -\frac{kq_2}{(.5-x)^2}$$

$$\frac{(2.1\times10^{-8})}{x^2} = -\frac{-4(2.1\times10^{-8})}{(.5+x)^2}$$

$$4x^2 = (.5+x)^2$$

$$3x^2 - x + .25 = 0$$

$$(3x+.5)(x-.5) = 0$$

Onlywantpositive solutions,so

$$x - .5 = 0$$

$$x = .5\text{meters} = 50\text{cm}$$

15. Let x be the distance between the two charges labeled +q. Let y be the distance from the charge + 2.0q to the point P.

$$x^2 = a^2 + a^2 = 2a^2$$

$$x = \sqrt{2}a$$

For the triangle with vertices + 2.0q, + q, and P :

$$a^2 = y^2 + \left(\frac{x}{2}\right)^2$$

$$y^2 = a^2 - \left(\frac{\sqrt{2}a}{2}\right)^2 = a^2 - \frac{a^2}{2} = \frac{a^2}{2}$$

$$E = \frac{kQ}{r^2} = \frac{k(2q)}{y^2} = \frac{4kq}{a^2}$$

$$k = \frac{1}{4\pi\pi_0} \Rightarrow E = \frac{q}{\pi\varepsilon_0 a^2}\text{, pointing away from } + 2.0q$$

**19.**

$$E_T = E_- + E_+$$

$$E_T = 2E_+\cos\Theta \text{, where } \cos\Theta = \frac{d}{2x}$$

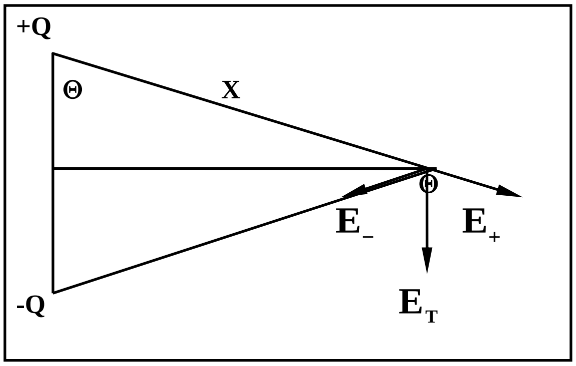
$$\text{and } x = \sqrt{\left(\frac{d}{2}\right)^2 + r^2}$$

$$E_+ = \frac{kQ}{x^2}$$

$$E_T = 2\left(\frac{kQ}{x^2}\right)\left(\frac{d}{2x}\right) = \frac{kQd}{x^3} = \frac{kp}{x^3}$$

$$\text{When } r >> \frac{d}{2}, x \approx \sqrt{r^2} = r$$

$$E_T = \frac{kp}{r^3}$$




**40.**

$$F = ma = qE$$

$$9.11\times10^{-31}a = (1.6\times10^{-19})(1\times10^3)$$

$$a = 1.76\times10^{14}\ \frac{m}{sec^2}$$

$$a)\ v^2 = v_0^2 - 2ax$$

$$0 = (5\times10^6)^2 - 2(1.76\times10^{14})x$$

$$x = 7cm$$

$$b)\ v = v_0 + at$$

$$0 = 5\times10^6 + (1.76\times10^{14})t$$

$$t = 28\times10^{-9}\,sec = 28ns$$

$$c)\ KE_I = \frac{m}{2}(5\times10^6)^2$$

$$@x = 8mm\ v = ?$$

$$v^2 = v_0^2 - 2ax$$

$$v^2 = (5\times10^6)^2 - 2(1.76\times10^{14})(.008)$$

$$v = 4.7\times10^6\ \frac{m}{sec}$$

$$KE_F = \frac{m}{2}(4.7\times10^6)^2$$

$$\frac{KE_I - KE_F}{KE_I} = \frac{(5\times10^6)^2 - (4.7\times10^6)^2}{(5\times10^6)^2} = .112$$

43.

$$E = 2\times10^{4}\ \frac{n}{C}$$

$$F = Eq = Ee = \left(2\times10^{4}\right)\left(1.6\times10^{-19}\right)$$

$$F = ma = 3.2\times10^{-15}$$

$$9.11\times10^{-31}a = 3.2\times10^{-15}$$

$$a = 3.51\times10^{15}\ \frac{m}{sec^{2}}$$

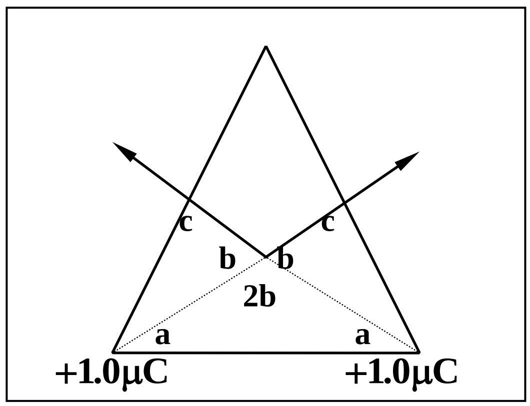
75.

Let $a = 30^{\circ}$

$b = 60^{\circ}$

$c = 90^{\circ}$

By symmetry, these two vectors would cancel out if a $+1\,\mu C$ charge were placed on top.




84. After 2 cm, is the electron still moving up?

$$F = Eq = ma$$

$$a = \frac{Ee}{m} = \frac{\left(2\times10^{3}\right)\left(1.6\times10^{-19}\right)}{9.11\times10^{-31}} = 3.5\times10^{14}\ \frac{m}{sec^{2}}$$

In the y – dir.

$$v_F^2 = v_0^2 - 2ax$$

$$v_F^2 = \left(6\times10^{6}\sin\left(45^{\circ}\right)\right)^{2} - 2\left(3.5\times10^{14}\right)\left(.02m\right)$$

$v_F = +2\times10^{6}$, Thus $e^{-}$ hits the top plate.

How long does it take?

$$y = v_{0y}t - \frac{1}{2}at^{2}$$

$$.02 = 6\times10^{6}\sin\left(45^{\circ}\right)t - \frac{1}{2}3.5\times10^{14}t^{2}$$

$$t = 6.4\times10^{-9}\,sec$$

$$x = v_{0x}t = \left(6\times10^{6}\cos\left(45^{\circ}\right)\right)\left(6.4\times10^{-9}\right)$$

$$x = 2.73cm$$