Example 1: Look back at the example worked out in your notes for Mon. 10/1-Wed. 10/3. Convince yourself that the electric fields due to the two charges, q, at position (0,b) for parts a and c of that problem are:

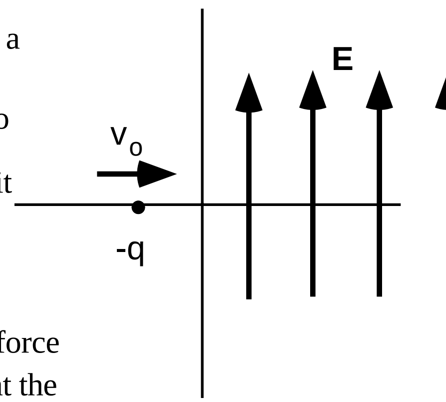
a) $\vec{E} = \dfrac{2kqb}{\left(a^2+b^2\right)^{3/2}}\hat{j}$ c) $\vec{E} = \dfrac{2kqa}{\left(a^2+b^2\right)^{3/2}}\hat{i}$

Other than at , ∞, where would the electric field due to the two small charges be 0 for parts a and c of that problem?

<u>Solution</u>: For part a), the elctric field due to the two qs is 0 at the origin. For part c), there is no place other than ∞ where the total electric field due to the + and - q is 0.

Example 2: A negative charge, -q, of mass, m, traveling horizontally with a speed v_o enters a region of space where there is a constant electric field, $E\hat{j}$, directed in the positive y direction (see diagram). Assume the gravitational force is very small compared to the electrical force.

a) Find an expression for the y-position of the charge after it travels a distance d in the x-direction.
b) How long did it take the charge to travel to the position described in part a)?



<u>Strategy for solving both a) and b)</u>: The charge, -q, experiences a force in the $-\hat{j}$ direction given by Coulomb's Law (recall we are told that the Coulomb force is much larger than the gravitational force). This force, according to Newton's Second Law, causes the charge to accelerate in the $-\hat{j}$ direction. The velocity in the x-direction remains constant at $v_o\hat{i}$ since there is no acceleration in that direction. Hence, apply Newton's Second Law to find the acceleration, and use the kinematic equations to determine both the y-position of the particle after it travels a horizontal distance, d, and the time it took to get there.

a) and b) <u>Solution</u>. The force on the charge is: $\vec{F}_{-q} = -qE_o\hat{j}$. By Newton's Second Law, $\vec{F}_{net} = m\vec{a}$, the acceleration of the charge under the influence of this force is:

$$\vec{a}_{-q} = 0\hat{i} - \frac{qE_o}{m}\hat{j}$$ (Note that the acceleration is in the -y-direction)

To find the time it took the charge to travel a distance d along the x-direction, simply apply the following kinematic equation, noting that a_x and x_o are 0.

$$x = x_o + v_{o,x}t + \frac{1}{2}a_x t^2 = 0 + v_o t + 0 \quad \Rightarrow \quad t = \frac{d}{v_o}$$

To find the y-position (at the time above) when the particle is at an x-position equal to d, apply the same kinematic equation, noting that now there is an acceleration in the y-direction:

$$y = y_o + v_{o,y}t + \frac{1}{2}a_y t^2 = 0 + 0 + \frac{1}{2}\left(-\frac{qE_o}{m}\right)\left(\frac{d}{v_o}\right)^2 = -\frac{qd^2E_o}{2mv_o^2}$$