At t=0 a very small object with mass 0.400mg and charge +9.00μC is travelling at 125 m/s in the -x-direction. The charge is moving in a uniform electric field that is in the +y-direction and that has magnitude E= 895 N/C. The gravitational force on the particle can be neglected. How far is the particle from the origin at t= 7.99 ms.

Solution

We are given

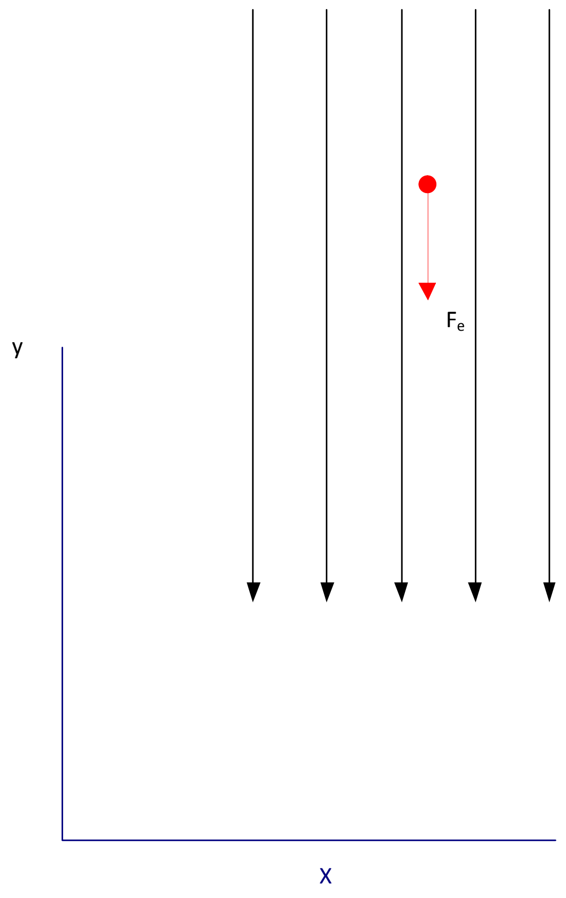
$$m = 0.400\ mg = 0.4 * 10^{-6} kg$$

$$q = +9.00\ \mu C = 9 * 10^{-6} C$$

$$v_0 = 125 \frac{m}{s}$$

$$E = 895 \frac{N}{C}$$

$$t = 7.99\ ms = 7.99 * 10^{-3} s$$



Equation of motion:

$$m * \vec{a} = \vec{F}$$

Projection on X-axis

$$m * a_x = F_x$$

Projection on Y-axis

$$m * a_y = F_y$$

Projection of forces:

$$F_y = F_e = q * E$$

$$F_x = 0$$

$F_x = 0$ means that $v_x = v_0 = const$

$$a_y = \frac{F_y}{m} = \frac{q * E}{m}$$

According to the definition of the acceleration:

$$a_y = \frac{d^2 y}{dt^2}$$

$$\frac{d^2 y}{dt^2} = \frac{q * E}{m}$$

Thus:

$$y = y_0 + v_{0_y} * t + \frac{\frac{q * E}{m} t^2}{2}$$

At t=0 object was moving only in x-direction so:

$$y_0 = 0;$$

$$v_{0_y} = 0;$$

Thus:

$$y(t) = \frac{\frac{q * E}{m} t^2}{2}$$

Calculating displacement in Y-direction

$$y(7.99\ ms) = \frac{\frac{9 * 10^{-6} * 895}{0.4 * 10^{-6}} (7.99 * 10^{-3})^2}{2} = 0.64\ m$$

displacement in X-direction

$$x(t) = v_0 * t$$

Calculating displacement in X-direction

$$x(7.99\ ms) = 125 * 7.99 * 10^{-3} = 0.998\ m$$

Total displacement:

$$r = \sqrt{x^2 + y^2}$$

$$r = \sqrt{0.998^2 + 0.64^2} = 1.186\ m$$

Answer:

$$\mathbf{1.186\ m}$$