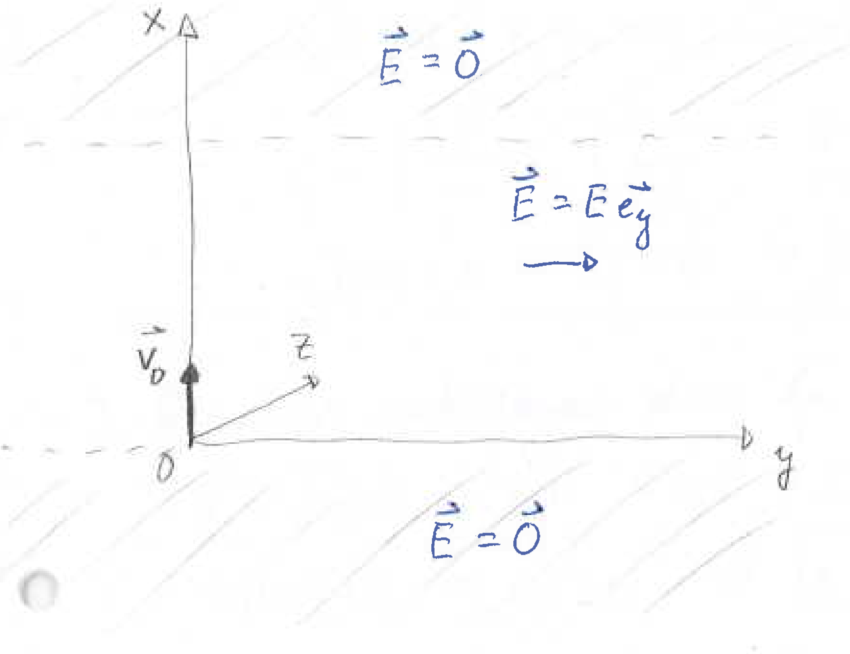
V. A. Mouvement d'une particule chargée
En présence d'un champ électrique $\vec{E}$



$q > 0$
ici donnés pour proton, p

1. Force électrique

$$\vec{F_e} = q\vec{E} = qE\vec{e_y}$$

$$\|\vec{F_e}\| = qE$$

$C = As$

A.N. : $\|\vec{F_e}\| \approx 1.6 \times 10^{-19} \times 3 \times 10^{5} \left[\frac{CV}{m}\right]$

$V = \frac{kg\, m^2}{A\, s^3}$

$$= 4.8 \times 10^{-14}\ [N]$$

Poids

$$\vec{F_g} = -mg\,\vec{e_x}$$

$$\|\vec{F_g}\| = mg \approx 1.67 \times 10^{-27} \times 9.81 \left[\frac{kg\, m}{s^2}\right]$$

$$\approx 1.64 \times 10^{-26}\ [N]$$

F_g négligeable devant F_e.

2. On néglige alors le poids.

$\overset{LFD}{\Rightarrow}$ $\vec{F_e} = m\vec{a}$

$$qE\vec{e_y} = m\dot{\vec{v}}$$

$$\boxed{\begin{array}{ll} \cdot\ \vec{e_x} \Rightarrow & \dot{v}_x = 0 \\ \cdot\ \vec{e_y} \Rightarrow & \dot{v}_y = \frac{qE}{m} \\ \cdot\ \vec{e_z} \Rightarrow & \dot{v}_z = 0 \end{array}}$$

$v_z = 0$ car ni force ni $\vec{v_0}$ en direction z.

$$\Rightarrow \quad v_x = \int 0 \, dt + C_x = C_x$$

$$v_x(t=0) = v_0 \Rightarrow C_x = v_0 \Rightarrow \boxed{v_x = v_0}$$

$$v_y = \int \frac{qE}{m} dt + C_y = \frac{qE}{m} t + C_y$$

$$v_y(t=0) = 0 \Rightarrow C_y = 0 \Rightarrow \boxed{v_y = \frac{qE}{m} t}$$

3. Équation cartésienne dans la zone $0 \leq x \leq L$

$$x = \int v_0 \, dt + C_x' = v_0 t + C_x'$$

$$x(t=0) = 0 \Rightarrow C_x' = 0 \Rightarrow \boxed{x = v_0 t}$$

$$y = \frac{qE}{m} \int t \, dt + C_y' = \frac{qE}{2m} t^2 + C_y'$$

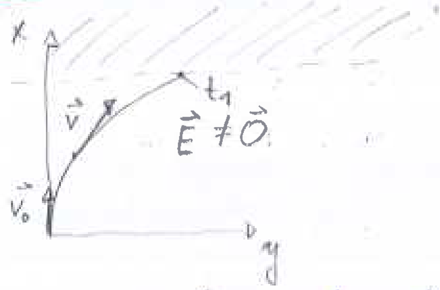
$$y(t=0) = 0 \Rightarrow C_y' = 0 \Rightarrow \boxed{y = \frac{qE}{2m} t^2}$$

trajectoire :

$$t^2 = \frac{2my}{qE} \Leftrightarrow t = \sqrt{\frac{2my}{qE}}$$

$$\Rightarrow \boxed{x(y) = v_0 \sqrt{\frac{2my}{qE}}}$$ fonction racine de y.

alors :



4. Zone sans champ (pas de poids)

LFD $\Rightarrow \boxed{\begin{array}{l} \dot{v}_x = 0 \\ \dot{v}_y = 0 \end{array}} \Rightarrow v_x = C_x$; $v_x(t_1) = v_0$; $\boxed{v_x = v_0}$

$$t_1 = \frac{x}{v_0} = \frac{L}{v_0}$$

$\Downarrow$

$$v_y = C_y \; ; \; v_y(t_1) = v_y\left(\frac{L}{v_0}\right) = \frac{qEL}{mv_0}$$

$$\Rightarrow \boxed{v_y = \frac{qEL}{mv_0}}$$

$$x = v_0 t + C_x' \quad ; \quad x(t_1) = L \Rightarrow \cancel{v_0}\frac{L}{\cancel{v_0}} + C_x' = L$$

$$\Rightarrow C_x' = 0$$

$$\Rightarrow \boxed{x = v_0 t}$$

$$y = \frac{qEL}{mv_0} t + C_y' \quad ; \quad y(t_1) = \frac{qEL^2}{mv_0^2} + C_y'$$

avec 3) nous avons la position $y(t_1)$:

$$y(t_1) = \frac{qEL^2}{2mv_0^2}$$

$$\Rightarrow \frac{qEL^2}{2mv_0^2} = \frac{qEL^2}{mv_0^2} + C_y' \qquad \Rightarrow C_y' = -\frac{qEL^2}{2mv_0^2}$$

$$\Rightarrow \boxed{y(t) = \frac{qEL}{mv_0} t - \frac{qEL^2}{2mv_0^2}}$$

$\Rightarrow$ équation de la trajectoire dans cette zone :

$$\frac{qEL}{mv_0} t = y + \frac{qEL^2}{2mv_0^2} \Leftrightarrow t = \frac{ymv_0}{qEL} + \frac{L}{2v_0}$$

$$\Rightarrow \boxed{x(y) = \frac{ymv_0^2}{qEL} + \frac{L}{2}}$$

trajectoire rectiligne

test : $y(t_1) = \frac{qEL^2}{mv_0^2} - \frac{qEL^2}{2mv_0^2} = \frac{qEL^2}{2mv_0^2}$

$\Rightarrow x(t_1) = \frac{L}{2} + \frac{L}{2} = L$ ✓