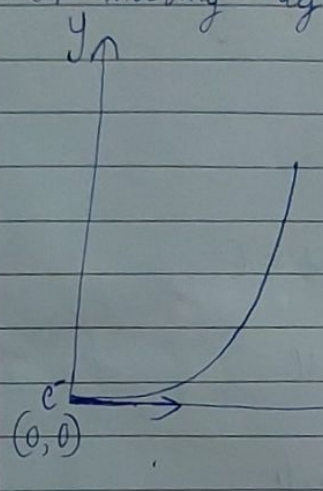
Name :- Bhushan Shinde

Roll no. :- 20221246 B-6

Q. There is an electric field $\vec{E} = -E\hat{j}$. From origin $(0,0)$ we gave an $e^-$ vel. $\vec{v} = v\hat{i}$, at the time $t = 0$, at the same time we give an uniform vel. $u\hat{j}$ to a infinite long wooden plate. Find out the eqn of trajectory of the $e^-$, required time to meet the wooden plate again and the coordinates of meeting again. [Given, mass of $e^- \longrightarrow m$, charge of $e^- \longrightarrow -e$]

→




$\vec{E} = -E.\hat{j}$

mass of $e^- = m$

charge of $e^- = -e$ [-ve]

initial vel. $= v.\hat{i}$

vel. of wooden plate $= u\hat{j}$

$\vec{F} = \vec{E}$ [charge of $e^-$]

$= +E.\hat{j}.+e$

$\boxed{\vec{F} = eE\hat{j}}$ --- (i)

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

from eqn (i) $\vec{a} = \frac{\vec{F}}{m} = \frac{eE}{m}.\hat{j}$

$x = v.t \longrightarrow t = x/v$ --- (iv)

$y = \frac{1}{2}at^2 \longrightarrow \frac{1}{2}\frac{eE}{m}t^2$ --- (v)

$\therefore y = \frac{1}{2}\frac{eE}{m}\left[\frac{x}{v}\right]^2 \longrightarrow \therefore \boxed{y = \frac{1}{2}\frac{eE}{mv^2}.x^2}$ ---- (ii)

$y_{wood} = u.t$ ---- (iii)

∴ from (ii) and (iii)

$$ut = \frac{1}{2}\frac{e\mathcal{E}}{m} \cdot t^2$$

$$\frac{1}{2}\frac{e\mathcal{E}}{m} t^2 - ut = 0$$

$$t\left[\frac{1}{2}\frac{e\mathcal{E}}{m} t - u\right] = 0$$

∴ In, Initial case

$t = 0$

$$\frac{1}{2}\frac{e\mathcal{E}t}{m} - u = 0$$

$$\frac{1}{2}\frac{e\mathcal{E}t}{m} = u$$

$$e\mathcal{E}t = 2m \cdot u$$

$$\therefore \boxed{t = \frac{2mu}{e \cdot \mathcal{E}}}$$

from eqn (iv)

$$X = v \cdot \frac{2mu}{e\mathcal{E}}$$

$$\boxed{X = \frac{2m \cdot uv}{e\mathcal{E}}}$$

from eqn (v)

$$y = \frac{1}{2}\frac{e\mathcal{E}}{mv^2}\left[\frac{2mu}{e\mathcal{E}}\right]^2$$

$$y = \frac{1}{2}\frac{e\mathcal{E}}{mv^2}\frac{4m^2u^2}{(e\mathcal{E})^2}$$

$$\boxed{y = \frac{2mu^2}{v^2 \cdot e\mathcal{E}}}$$

∴ Point at which the wooden plate and the $e^-$ will meet again is → $\left(\frac{2muv}{e\mathcal{E}}, \frac{2mu^2}{v^2 \cdot e\mathcal{E}}\right)$