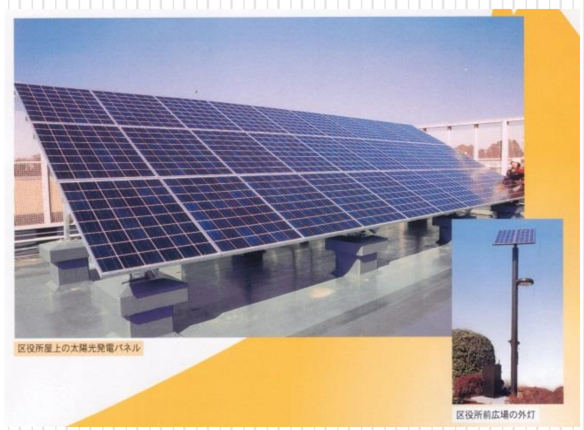
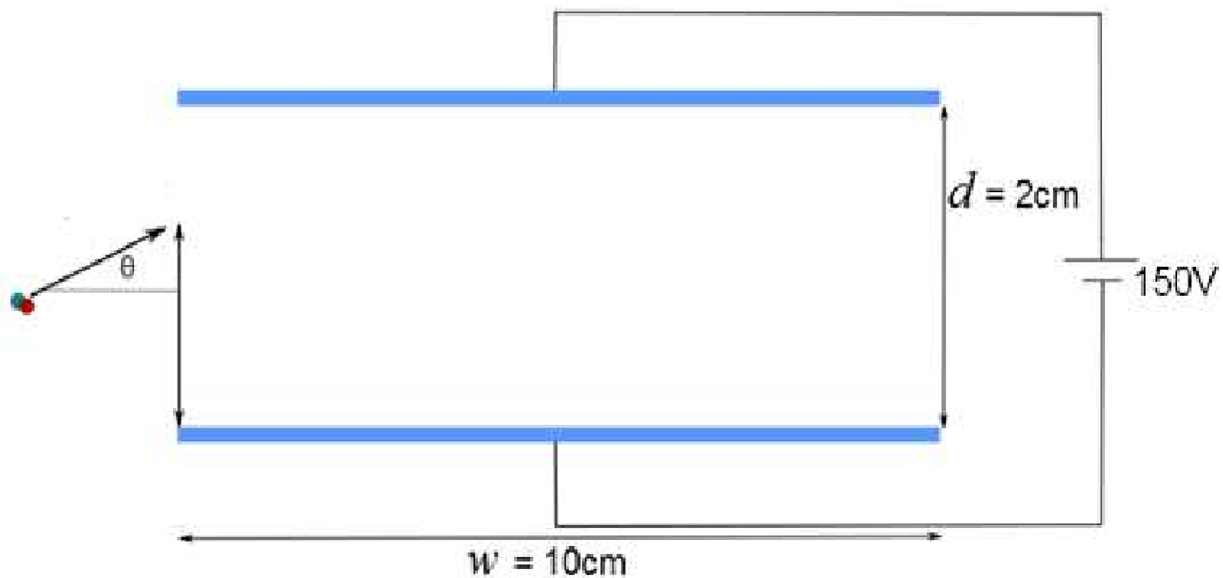
Sheet (04)



A proton is fired at a velocity of $5 * 10^6$ m/s an angle θ between two charged plates within a conventional tube with a separation of 2cm and a length of 10cm and a potential difference of 150V. The charge enters the field in the middle of the plates, as shown in the figure below. Get the expressions describing the trajectory of proton if the mass of the proton $1.6*10^{-27}$kg. The charge of proton is $1.6*10^{-19}$.



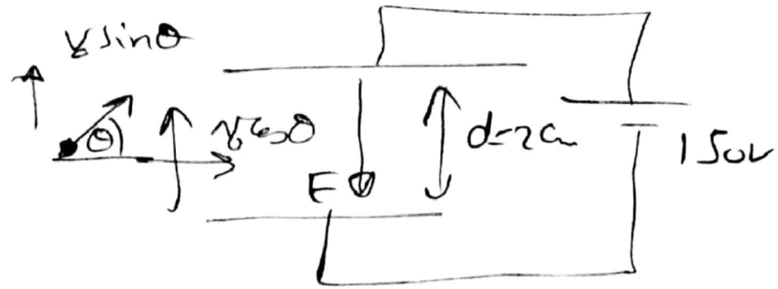
$m = 1.6 \times 10^{-27}$ kg

$q = 1.6 \times 10^{-19}$

$v = 5 \times 10^{6}$

$E = 150V$

$d = 2\,cm$



sol

$\rightarrow \dfrac{dx}{dt} = v_0 \cos\theta \quad , \quad \dfrac{dy}{dt} = v_0 \sin\theta$

$\rightarrow F = m \dfrac{d^2x}{dt^2} \quad \therefore F_x = 0$

at $t = 0$ $\quad V_{0x} = V_0 \cos\theta$

$\therefore \dfrac{d^2x}{dt^2} = 0 \quad \therefore \boxed{\dfrac{dx}{dt} = C_1 = V_0 \cos\theta} \rightarrow (1)$

$x = (V_0 \cos\theta)\, t + C_2$ $\quad$ at $t = 0$ $\quad x = 0 \quad \therefore C_2 = 0$

$\therefore \boxed{x = (V_0 \cos\theta)\, t}$

$$\vec{F}_y = q\vec{E} = -q\vec{E}_{ay} = -q\left(\frac{V}{d}\right)$$

$$\therefore m\frac{d^2y}{dt^2} = -\frac{qV}{d} \qquad \therefore \frac{d^2y}{dt^2} = -\frac{qV}{md}$$

$$\therefore \frac{dy}{dt} = \frac{-qV}{md}t + c_3$$

at $t=0$ $\frac{dy}{dt} = V_{y0} = V_0 \sin\theta$ $\therefore c_3 = V_0 \sin\theta$

$$\therefore \frac{dy}{dt} = -\frac{qV}{md}t + V_0\sin\theta$$

$$\therefore y = -\frac{qV}{md}\frac{t^2}{2} + (V_0\sin\theta)t + c_4$$

at $t=0$ $y=0$ $\therefore c_4 = 0$

$$\therefore y = -\frac{qV}{md}\frac{t^2}{2} + (V_0\sin\theta)t$$

(2)

From x → $t = \dfrac{x}{V_o \cos\theta}$

in y

$$y = -\frac{qV}{2md}\left[\frac{x}{V_o\cos\theta}\right]^2 + (V_o \sin\theta)\frac{x}{V_o\cos\theta}$$

$$y = -\frac{qV x^2}{2mdV_o^2\cos^2\theta} + x\tan\theta$$

$$= -\frac{1.6\times10^{-19}\times150\, x^2}{2\times1.6\times10^{-27}\times2\times10^{-2}\times(5\times10^{6})^2\cos^2\theta} + x\tan\theta$$

$$y = -\frac{0.0143}{\cos^2\theta}x^2 + x\tan\theta$$

Thank you for your attention