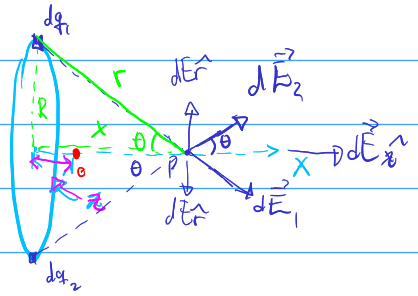
Actividad 2

1.



$\Rightarrow \vec{E}(P) = \vec{E}_\lambda \qquad dq = \lambda dl$

$d\vec{E} = \frac{k \cdot dq\, \vec{r}}{r^3}$

$\vec{r} = -R(\hat{r}) + x(\hat{i})$

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

$d\vec{E} = \frac{k \cdot \lambda dl_1}{(R^2+x^2)^{3/2}}(-R(\hat{r}) + x(\hat{i}))$

$d\vec{E} = \frac{k\lambda x}{(R^2+x^2)^{3/2}} dl\,(\hat{i}) \rightarrow \vec{E} = \frac{k\lambda x}{(R^2+x^2)^{3/2}} \int_0^L dl\,(\hat{i})$

$\vec{E}(P) = \frac{k\frac{Q}{L}x}{(R^2+x^2)^{3/2}} \cdot L\,\hat{i}$

$\vec{F}_E = q\vec{E}$

$\uparrow -e$

$\vec{F}_E = -e\vec{E}$

$\vec{E}(P) = \frac{kQx}{(R^2+x^2)^{3/2}}\hat{i}$

$$\boxed{\vec{F}_E = -\frac{keQx}{(R^2+z^2)^{3/2}}\hat{i} \quad (a)}$$

b) Podemos ver la expresión de $\vec{F}_E$

$\vec{F}_E = -\frac{keQx}{R^2} \cdot \underbrace{\frac{R^2}{(\sqrt{R^2+z^2})^3}}_{\approx 1}\hat{i}$ como $R \gg z$

$\vec{F}_E = -\frac{keQx}{R^2}\hat{i}$

$\vec{F}_E = -\frac{eQ}{R^2 4\pi\varepsilon_0}x\,\hat{i}$ ← tiene forma de una fuerza restauradora

$$\sum F = ma$$

$$\frac{-eQ}{4\pi\epsilon_0 R^2} x = m_e x''$$

m_e = masa electron

$$m_e x'' + \frac{eQ}{4\pi\epsilon_0 R^2} x = 0$$

$$\boxed{x'' + k\frac{eQ}{R^2 m_e} x = 0} \quad (b)$$

c) $x'' + k\cdot\frac{eQ}{m_e R^2} x = 0 \rightarrow x'' + \omega^2 x = 0$

$$\omega^2 = \frac{keQ}{m_e R^2} \rightarrow \omega = \sqrt{\frac{keQ}{m_e R^2}} \rightarrow f = \frac{1}{2\pi}\sqrt{\frac{keQ}{m_e R^2}}$$

$$\boxed{f = 34{,}68\ MHz \qquad T = \frac{1}{f} = 28{,}83\ ns}$$

d) $x(t) = A\cos(\omega t + \phi)$ $\phi = 0°$ porque $v_0 = 0$

$A = 5\mu m \rightarrow x(t) = 5\cos(2{,}18\times10^8 t)$ [μm]

$V(t) = -A\omega \operatorname{sen}(\omega t)$

$\rightarrow V(t) = 1{,}09\times10^3 \operatorname{sen}(2{,}18\times10^8 t)$ [m/s]

$a(t) = -A\omega^2\cos(\omega t)$

$\rightarrow a(t) = -2{,}38\times10^{11}\cos(2{,}18\times10^8 t)$ [m/s^2]

e) max $x = 5\mu m$ $a = 2{,}38\times10^{11}\ m/s^2$

$v = 1{,}09\times10^3\ m/s$

f) luego de 10 ns

$x(10ns) = -2.86 \times 10^{-6}\ m$

$v(10ns) = 8.29 \times 10^{2}\ m/s$

$a(10ns) = 1.36 \times 10^{4}\ m/s^2$

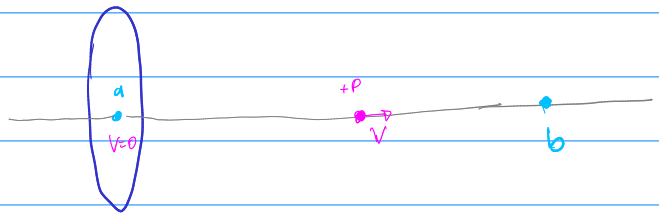
g) $dV = \frac{K dq}{r}$ $\qquad r = \sqrt{R^2 + z^2}$

$\Rightarrow dV = \frac{K\, dq}{\sqrt{R^2+z^2}} \Rightarrow V = \frac{K}{\sqrt{R^2+z^2}} \int_0^a dq \Rightarrow V = \frac{KQ}{\sqrt{R^2+z^2}}$

La energia Potelc. $= V \cdot q \Rightarrow E_p = V \cdot q = \frac{K \cdot Q}{\sqrt{R^2+z^2}} \cdot +e$

$E_p = 2.16 \times 10^{-14}\ J$

h) $E_{ma} = E_{mb}$



$E_{pa} + \cancel{E_{ca}}^{0} = E_{pb} + \cancel{E_{cb}}^{0}$

$E_{pa} = E_{cb}$

$2.16 \times 10^{-14} = \frac{1}{2} m_p V^2$

$\sqrt{\frac{2 \cdot 2.16 \times 10^{-14}}{m_p}} = V_f$

$V_f = 5.09 \times 10^{6}\ m/s$