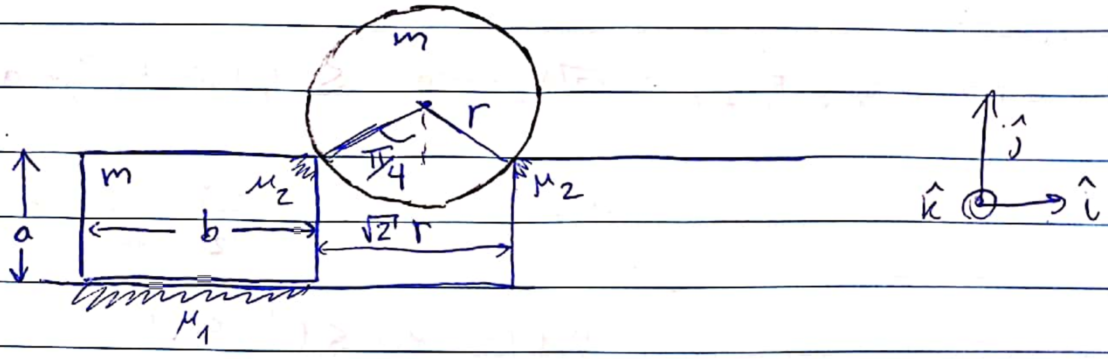
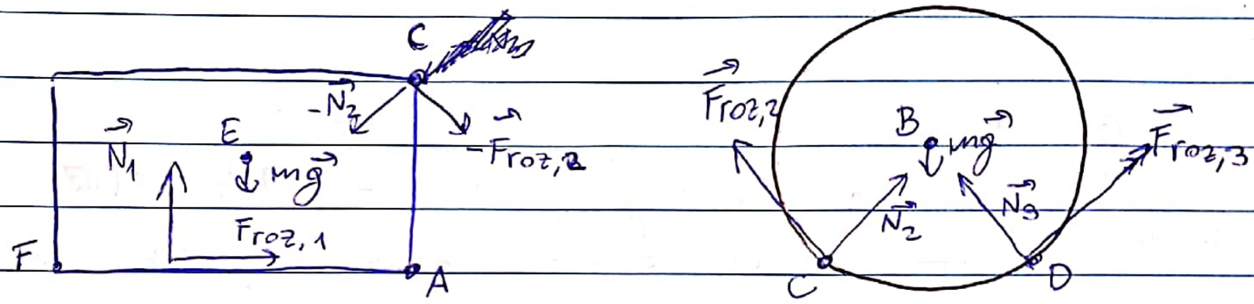
1)





$m\vec{g} = -mg\,\hat{j}$ $\quad \vec{N}_1 = N_1\,\hat{j}$, $N_1 \geq 0$ $\quad \vec{F}_{roz,1} = F_{roz,1}\,\hat{i}$, $-\mu_1 N_1 \leq F_{roz,1} \leq \mu_1 N_1$ $\quad \vec{N}_2 = \frac{N_2}{\sqrt{2}}(\hat{i}+\hat{j})$, $N_2 \geq 0$ $\quad \vec{F}_{roz,2} = \frac{F_{roz,2}}{\sqrt{2}}(-\hat{i}+\hat{j})$, $-\mu_2 N_2 \leq F_{roz,2} \leq \mu_2 N_2$

$\vec{N}_3 = \frac{N_3}{\sqrt{2}}(-\hat{i}+\hat{j})$, $N_3 \geq 0$ $\quad \vec{F}_{roz,3} = \frac{F_{roz,3}}{\sqrt{2}}(\hat{i}+\hat{j})$, $-\mu_2 N_3 \leq F_{roz,3} \leq \mu_2 N_3$

$\vec{r}_c - \vec{r}_B = -\frac{r}{\sqrt{2}}(\hat{i}+\hat{j}) \quad \vec{r}_D - \vec{r}_B = \frac{r}{\sqrt{2}}(\hat{i}-\hat{j}) \to \vec{\tau}_{cilindro,B} = 0 \Rightarrow \boxed{F_{roz,2} = F_{roz,3}}$

$\vec{F}_{Neta,cilindro} = 0 \quad \to \hat{i})\ \boxed{N_2 = N_3}$

$\to \hat{j})\ \boxed{N_2 + F_{roz,2} = \frac{mg}{\sqrt{2}}}$

$\vec{F}_{Neta,bloque} = 0 \quad \to \hat{i})\ F_{roz,1} + \frac{F_{roz,2} - N_2}{\sqrt{2}} = 0$

$\to \hat{j})\ N_1 - mg - \frac{F_{roz,2} + N_2}{\sqrt{2}} = 0 \to \boxed{N_1 = \frac{3}{2}mg}$

$\boxed{F_{roz,1} - \sqrt{2}\,N_2 + \frac{mg}{2} = 0}$ (1) $\to$ si no desliza $\boxed{1 \leq \frac{mg}{2\sqrt{2}\,N_2}(1+3\mu_1)}$

rotación horaria

rotación antihoraria

$\vec{\tau}_{N_1,A} = -\tau_{N_1,A}\,\hat{k}$ con $0 \leq \tau_{N_1,A} \leq \frac{b\,3mg}{2}$ xq N_1 es hacia arriba y se hace distribuida a la izq. de A pero no más allá de F.

$\vec{\tau}_{bloque,A} = 0 \to \boxed{\tau_{N_1,A} = mg\frac{b}{2} + (N_2 - F_{roz,2})\frac{a}{\sqrt{2}}}$ (2)

De ① es $-\mu_1 N_1 \le F_{roz,1} = \sqrt{2}\, N_2 - mg \le \mu_1 N_1 = \mu_1 \frac{3}{2} mg$

$\Rightarrow$ No desliza si

$$\boxed{1 \underset{(D1)}{\le} \frac{mg}{N_2}\frac{1}{2\sqrt{2}}(1+3\mu_1)}$$ cond. no deslizar hacia la izquierda.

$$\boxed{1 \underset{(D2)}{\ge} \frac{mg}{N_2}\frac{1}{2\sqrt{2}}(1-3\mu_1)}$$ cond no deslizar hacia la derecha.

De ② tenemos que $\tau_{N_1,A} = mg\frac{b}{2} + a\left(\sqrt{2}\, N_2 - \frac{mg}{2}\right)$

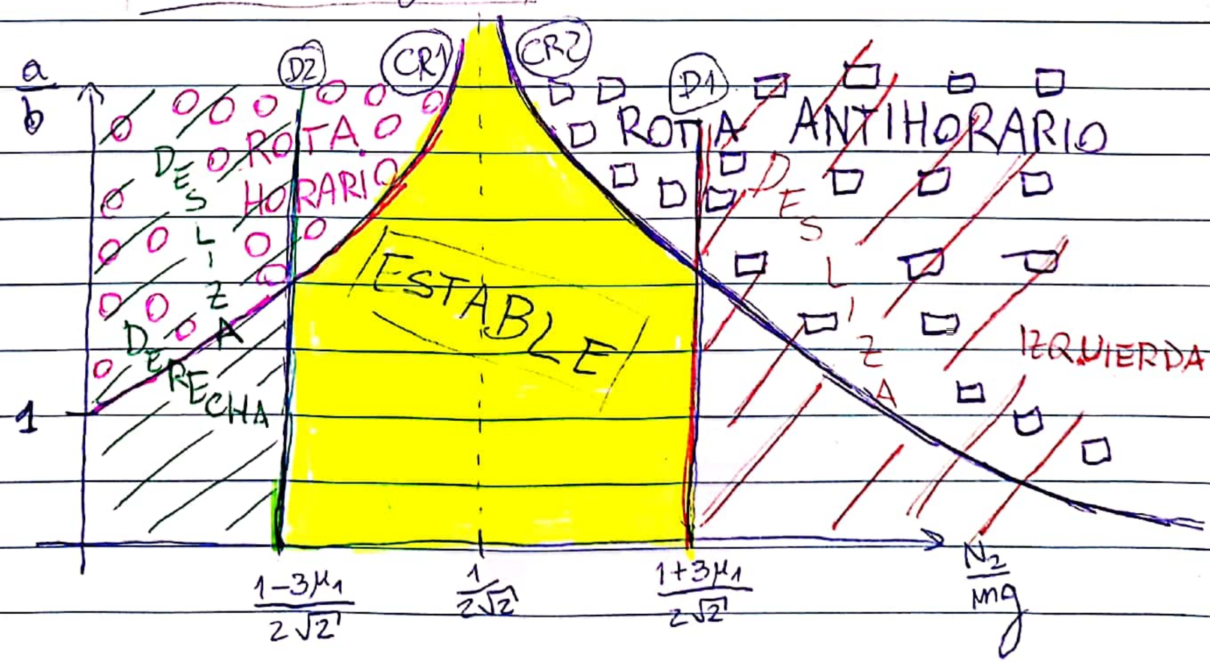
$$\Rightarrow 0 \underset{(CR1)}{\le} \frac{mgb}{2}\left[\left(1-\frac{a}{b}\right) + 2\sqrt{2}\,\frac{N_2}{mg}\frac{a}{b}\right] \underset{(CR2)}{\le} 3\,\frac{mgb}{2}$$

cond. de no rotar en sentido horario

cond. de no rotar en sentido antihorario

$$\Rightarrow \boxed{\frac{a}{b} \underset{(CR1)}{\le} \frac{1}{1-2\sqrt{2}\,\frac{N_2}{mg}}}$$ cond. de no rotar en sentido horario

$$\boxed{\frac{a}{b} \underset{(CR2)}{\le} \frac{2}{2\sqrt{2}\,\frac{N_2}{mg}-1}}$$ cond. de no rotar en sentido anti-horario



2) a) $v_A = \dfrac{\Delta x_0}{\Delta t_0}$ $\qquad \Delta x_0 = 1/4$ a-l. ← año-luz

$\qquad \qquad \Delta t_0 = 1/3$ a. ← año

$\Rightarrow v_A = \dfrac{3}{4}c$

$v_B = 0{,}99c$

$$\left.\begin{array}{l} x_E = \Delta x_0 + v_A(t_E - \Delta t_0) \\ x_E = v_B(t_E - \Delta t_0) \end{array}\right\} \Rightarrow \frac{\Delta x_0}{v_B - v_A} + \Delta t_0 = t_E \approx 1{,}375 \text{ a}$$

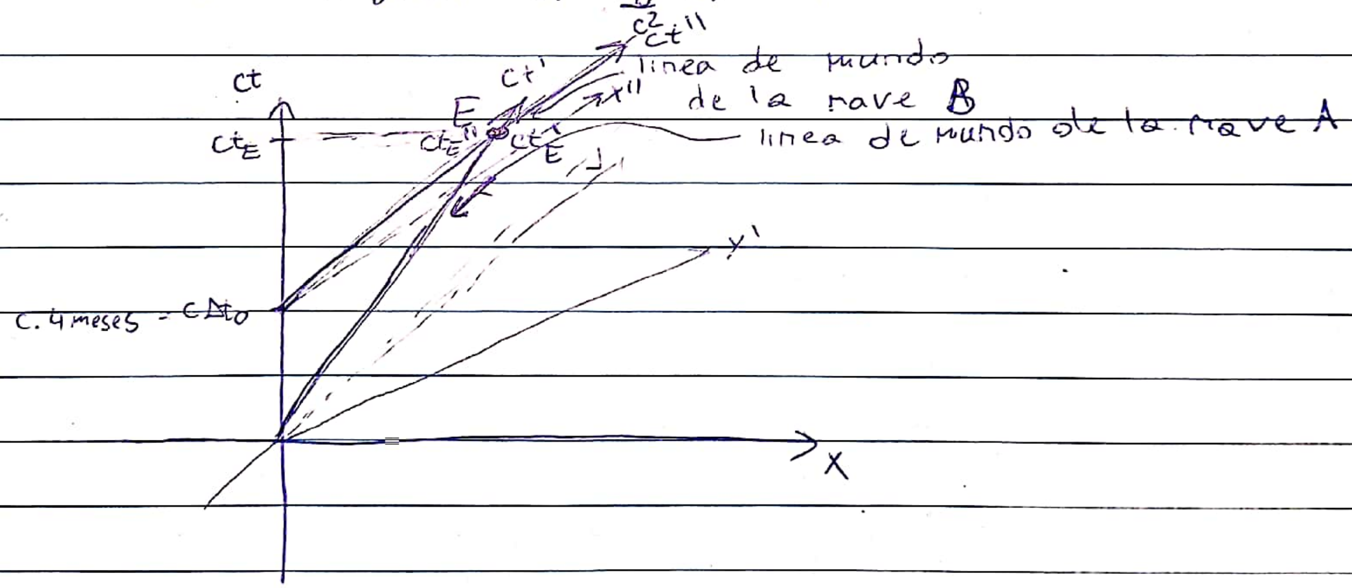
$$\Rightarrow x_E = v_B(t_E - \Delta t_0) \approx 1{,}031 \text{ a-l.}$$

b) Es inmediato que $x'_E = x''_E = 0$ ya que es lo que caracteriza al evento "encuentro"

$$t'_E = \gamma(v_A)\left(t_E - \frac{v_A}{c^2}x_E\right) \approx 0{,}910 \text{ a}$$

$$t''_E = \gamma(v_B)\left((t_E - \Delta t_0) - \frac{v_B}{c^2}x_E\right) \approx 0{,}021 \text{ a}$$

c)



d) $v''_A = \dfrac{v_A - v_B}{1 - \dfrac{v_A v_B}{c^2}} \approx -0{,}932c$

3) a) $E = cte = q V_{el.} + K$ $\quad q = -e \quad e = 1{,}6 \times 10^{-19}\,C.$

$\Rightarrow -e\, V_{el}(final) + K_{final} = -e\, V_{el}(inicial) + K_{inicial}$

$\Rightarrow K_{inicial} = 0 \quad K_{final} = \frac{m_e c^2}{2}$

$\Rightarrow V_{el}(final) - V_{el}(inicial) = \Delta V = + \frac{m_e c^2}{2e} \approx 0{,}255\ MV$

b) $\Delta V e = K$ sigue siendo cierto

$= (\gamma(v_e) - 1)\, m_e c^2$

$\Rightarrow \gamma(v_e) = 1 + \frac{1}{2}\frac{m_e c^2}{m_e c^2} = \frac{3}{2} \Rightarrow \boxed{v_e = c\sqrt{1 - \frac{1}{\gamma^2}} = \frac{\sqrt{5}}{3}\, c}$

c) $K = \Delta V e = 0{,}255\ MeV.$

y $m_e(v_e) = \gamma(v_e)\, m_e \approx 1{,}366 \times 10^{-30}\ kg$

d) $\vec{F} = \frac{d\vec{P}}{dt} = m\vec{a} + \frac{(\vec{F}\cdot\vec{v})\,\hat{v}}{c^2} \Rightarrow$ como $\vec{F} \parallel \vec{v} \rightarrow \vec{F} = F\,\hat{v}$ y será $\vec{a} = a\,\hat{v}$

$\Rightarrow \hat{v}\,\Big|\ F\underbrace{\left(1 - \frac{v^2}{c^2}\right)}_{\frac{1}{\gamma^2}} = m a = m_e(v)\, a = m_e \gamma\, a$

$\Rightarrow a = \frac{F}{m_e}\left(1 - \frac{v^2}{c^2}\right)^{3/2}$

En este caso $F = e|\vec{E}|$

$\Rightarrow a = \frac{e|E|}{m_e}\left(1 - \frac{v^2}{c^2}\right)^{3/2}$

e) $u = \frac{e|\vec{E}|t}{m_e\sqrt{1 + \left(\frac{e|\vec{E}|t}{m_e c}\right)^2}} \Rightarrow \frac{du}{dt} = a = \frac{e|\vec{E}|}{m_e\sqrt{1 + \left(\frac{e|\vec{E}|t}{m_e c}\right)^2}} - \frac{\frac{e|\vec{E}|t}{m_e}\cdot\left(\frac{e|\vec{E}|}{m_e c}\right)^2 t}{\left(1 + \left(\frac{e|\vec{E}|t}{m_e c}\right)^2\right)^{3/2}}$

$A = \frac{e|\vec{E}|}{m_e c}$

$= \frac{e|\vec{E}|}{m_e\left(1 + \left(\frac{e|\vec{E}|t}{m_e c}\right)^2\right)^{3/2}} = \frac{e|\vec{E}|}{m_e \gamma^3}$

$\Rightarrow \frac{u}{c} = \frac{At}{\sqrt{1 + (At)^2}} \Rightarrow \frac{u^2}{c^2} = A^2 t^2\left(1 - \frac{u^2}{c^2}\right)$

$\Rightarrow (At)^2 = \frac{u^2}{c^2}\gamma^2 \Rightarrow 1 + A^2 t^2 = \frac{1}{1 - \frac{u^2}{c^2}} = \gamma^2$

$\Rightarrow \int a\,dt = \int \frac{du}{dt}\,dt = u(t) - u(0) = \frac{e|\vec{E}|t}{m_e\sqrt{1 + \left(\frac{e|\vec{E}|t}{m_e c}\right)^2}}$

$\parallel$

$\int \frac{e|\vec{E}|}{m_e \gamma^3(u)}\,dt$

$x(t) = x(0) + \int_0^t u\,dt' = x(0) + \frac{m_e c^2}{e|\vec{E}|}\sqrt{1 + \left(\frac{e|\vec{E}|t'}{m_e c}\right)^2}\,\Bigg|_0^t = x(0) + \frac{m_e c^2}{e|\vec{E}|}\left[\sqrt{1 + \left(\frac{e|\vec{E}|t}{m_e c}\right)^2} - 1\right]$