PARCIAL - FÍSICA MODERNA JUNIO 2009

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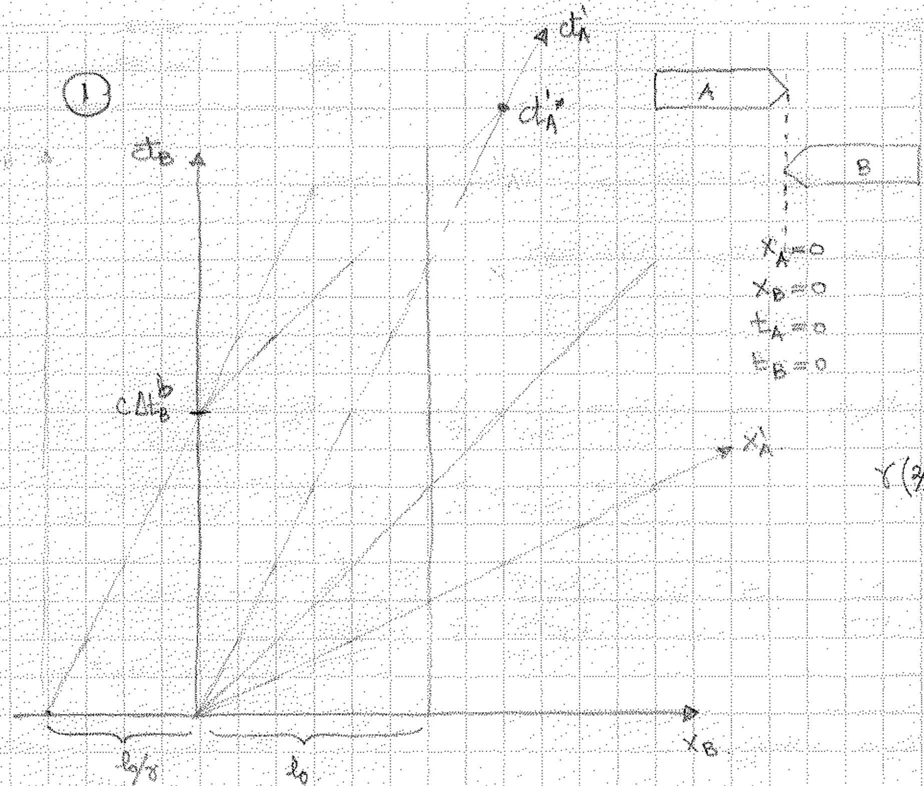
$l_B = l_A = 100\,m = l_0$

$\Delta t = 5 \times 10^{-7}\,s$



$x'_A = \gamma (x_B - v t_B)$ (I)

$t'_A = \gamma \left(t_B - \frac{v}{c^2} x_B\right)$ (II)

$\gamma(2/3) = \dfrac{1}{(1-4/9)^{1/2}} = \dfrac{3}{\sqrt{5}}$

a) $v = \dfrac{l_0}{\Delta t'_A} \rightarrow \beta = 2/3$

b) $\Delta t_B = \dfrac{l_0}{\gamma v} = 3{,}73 \times 10^{-7}\,s \longrightarrow \Delta t_B = \dfrac{\Delta t'_A}{\gamma}$

Considerando (II) con $\Delta x_B = 0$ dado que el reloj de B no cambia de posición, según B.

c) $x_A(t^*_B) = v\, t^*_B$ posición de A en el referencial de B.

$x_L(t^*_B) = c\,(t^*_B - \Delta t_B(b))$ $\quad t^*_B \Rightarrow x'_A(t^*_B) = x_L(t^*_B)$

$$t^*_B = \frac{c\,\Delta t_B(b)}{c - v} = 1{,}12 \times 10^{-6}\,s$$

$$t'^*_A = \gamma\left(t^*_B - \frac{v}{c^2} x_A(t^*_B)\right) = \gamma\left(t^*_B - \frac{v^2}{c^2} t^*_B\right) = \gamma\,(1 - v^2/c^2)\, t^*_B$$

$$t'^*_A = (1 - v^2/c^2)^{1/2}\, t^*_B = 8{,}33 \times 10^{-7}\,s$$

DEMO (c): $t^*_A = \dfrac{(1 - v^2/c^2)^{1/2}}{1 - v/c}\,\dfrac{l_0}{\gamma v} = \dfrac{(1 - v^2/c^2)}{(1 - v/c)}\,\dfrac{l_0}{v} = (1 + v/c)\,\dfrac{l_0}{v} = l_0/v + \dfrac{l_0}{c}$

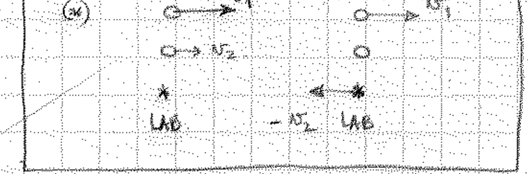
lo que tarda B en recorrer A, según A

lo que tarda la luz en recorrer la nave A

(b) OTRA FORMA: $\Delta t_B = \gamma\left(\Delta t'_A + \frac{v}{c^2}\Delta x'_A\right) = \gamma\left(\Delta t'_A - \frac{v}{c^2} l_0\right) = \gamma\left(\Delta t'_A - 2/3\,\frac{l_0}{c}\right)$

$\Delta x'_A = -l_0$

(2) $E_1 = 5\,GeV \quad p_1 = 3\,GeV/c$



a) $p_2 = 4\,GeV/c \quad E_2 = ?$

$E_1^2 = p_1^2c^2 + m_0^2c^4$

$25 = 9 + m_0^2c^4 \rightarrow m_0^2c^4 = 16 \rightarrow m_0c^2 = 4\,GeV$

$E_2^2 = 16 + 16 = 32 \rightarrow E_2 = 4\sqrt{2}\,GeV$

b) $m_0 = 4\,GeV/c^2$

c) $p_1 = M(v_1)v_1 = \gamma_1 m_{0_1} v_1 \rightarrow \gamma_1 v_1 = \frac{p_1}{m_{01}} = \frac{3}{4}c \rightarrow v_1/c = \left(\frac{9/16}{9/16+1}\right)^{1/2} = \frac{3}{5}$

$\gamma_2 v_2 = \frac{p_2}{m_{02}} = c \rightarrow v_2/c = \left(\frac{1}{1+1}\right)^{1/2} = \frac{1}{\sqrt{2}}$

$$\boxed{\begin{aligned} \gamma v/c = \alpha &\rightarrow \frac{v/c}{(1-v^2/c^2)^{1/2}} = \alpha \\ \frac{v^2/c^2}{(1-v^2/c^2)} = \alpha^2 &\rightarrow v^2/c^2 = \frac{\alpha^2}{1+\alpha^2} \end{aligned}}$$

(*) $u'_x = \frac{u_x - v}{1 - \frac{u_x v}{c^2}} = \frac{3/5 - 1/\sqrt{2}}{1 - 3/5\sqrt{2}} = -0{,}186\,c$

$\begin{cases} u'_x = v'_1;\ u_x = v_1 \\ v = v_2 \end{cases}$

(3) $p_1 = 1{,}75\,MeV/c \quad m_{0_1} = 1\,MeV/c^2$

$p_2 = 2{,}0\,MeV/c \quad m_{0_2} = 1{,}5\,MeV/c^2$

(A) $E_A = E_D \quad E_A^2 = p_A^2c^2 + m_{0A}^2c^4$

$E_D = E_1 + E_2 \ / \ E_1 = \left(p_1^2c^2 + m_{01}^2c^4\right)^{1/2} = (1{,}75^2 + 1^2)^{1/2} = 2{,}016\,MeV$

$E_2 = \left(p_2^2c^2 + m_{02}^2c^4\right)^{1/2} = (2{,}0^2 + 1{,}5^2)^{1/2} = 2{,}5\,MeV$

(B) $p_{Ax} = p_{Dx} \rightarrow 1{,}75 = \gamma(v)\, m_{0A}\, v_{x_A} \qquad v^2 = (v_{x_A}^2 + v_{x_B}^2)$

$p_{Ay} = p_{Dy} \rightarrow 2{,}0 = \gamma(v)\, m_{0A}\, v_{y_A}$

x(A) $E_A^2 = (E_1 + E_2)^2 = 20{,}39 = p_A^2c^2 + m_{0A}^2c^4 \rightarrow p_A^2 = p_1^2 + p_2^2 = (1{,}75^2 + 2{,}0^2)\,MeV^2/c^2$

$m_{0A}^2c^4 = (E_1+E_2)^2 - (p_1^2+p_2^2)c^2 \rightarrow m_0c^2 = 3{,}65\,MeV$

(B) $p_A^2 = (p_1^2 + p_2^2) = \gamma^2(v)\, m_{0A}^2\, v^2 \rightarrow \gamma^2(v)\, v^2/c^2 = 0{,}53 = \frac{v^2/c^2}{1 - v^2/c^2}$

$(1 - v^2/c^2) \times 0{,}53 = v^2/c^2 \rightarrow v^2/c^2 = \frac{0{,}53}{1+0{,}53} = 0{,}346 \rightarrow v/c = 0{,}589$

$\gamma = (1 - v^2/c^2)^{1/2} = 1{,}2365$

$v_{x_A} = 1{,}75/1{,}2365/m_{0A} = 0{,}388\,c$

$v_{y_A} = 2{,}0/1{,}2365/m_{0A} = 0{,}443\,c$