① $m_0 = 2\,mg \qquad v = \frac{c}{2} \qquad m = \gamma \cdot m_0$

a) $m = \gamma \cdot m_0 \qquad m = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \cdot m_0 = \frac{1}{\sqrt{1 - \frac{(c/2)^2}{c^2}}} \cdot 2 = 2{,}31\,mg.$

b) $E_{c\,relativista} = mc^2 - m_0 c^2 = (m - m_0) \cdot c^2$

$E_{c\,relat.} = [(2{,}31 - 2) \cdot 10^{-6}] \cdot (3 \cdot 10^8)^2 = 2{,}79 \cdot 10^{10}\ J$

② $v = 0{,}9\,c \qquad \Delta t = \gamma \cdot \Delta t_0 \qquad \gamma = \frac{1}{\sqrt{1 - 0{,}9^2}} = 2{,}29$

$t_0 = 1\,h.$

$\Delta t = 2{,}29 \cdot 1 = 2{,}29\,h$

↓ teda 0' 11"

2h 17' 24"

El reloj en tierra marcará las 2:17:24. (14:17:24).

③ $L_0 = 100m$. $L = 99m$. ¿ v? $L_0 = \gamma \cdot L$

$$L_0^2 = \frac{1}{1-\frac{v^2}{c^2}} \cdot L^2 \Rightarrow 1 - \frac{v^2}{c^2} = \left(\frac{L}{L_0}\right)^2 \Rightarrow \frac{v^2}{c^2} = 1 - \left(\frac{L}{L_0}\right)^2$$

$$v^2 = \left[1 - \left(\frac{L}{L_0}\right)^2\right] \cdot c^2 \Rightarrow \quad v = c \cdot \sqrt{1 - \frac{L^2}{L_0^2}}$$

$$v = 3.10^8 \cdot \sqrt{1 - \left(\frac{99}{100}\right)^2} = 4{,}23.10^7 \ \frac{m}{s}$$

④ $E_{reposo} \rightarrow \boxed{E_0 = m_0 \cdot c^2}$ $\quad E_0 = 1{,}674927.10^{-27} (3.10^8)^2 = 1{,}51.10^{-10} J$

$E_{cinét.\ relativ}: \ E = (m - m_0) \cdot c^2 \qquad m = \gamma \cdot m_0 = \frac{1{,}674927.10^{-27}}{\sqrt{1 - 0{,}5^2}} = 1{,}934.10^{-27}$

$$E_{crelat} = (1{,}934.10^{-27} - 1{,}674927.10^{-27}) (3.10^8)^2$$

$$E_{crelativ} = 2{,}33.10^{-11} J$$

⑤ $m_0 = 70\ kg.$ $\quad m = \gamma . m_0.$

$$m = \frac{70}{\sqrt{1-0,6^2}} = 87,5\ kg.$$

⑥ $L_0 = 50m \quad L = 30m.$

$$v = c.\sqrt{1-\left(\frac{L}{L_0}\right)^2} = 3.10^8 \sqrt{1-\left(\frac{30}{50}\right)^2} = 2,4.10^8\ \frac{m}{s}$$

⑦ a) $E = m.c^2 = 1.(3.10^8)^2 = 9.10^{16}\ J = 90000\ TJ$

b) $p = m.v \qquad \boxed{m = \gamma . m_0}$

$$p = \gamma . m_0 . v = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} . m_0 . v$$

$$p = \frac{1}{\sqrt{1-\frac{(c/2)^2}{c^2}}} . 1kg . \frac{3.10^8}{2} = 1,75.10^8\ kg.\frac{m}{s}$$

(8) $L_0 = l$ $\quad v = ?$ $\quad l = \frac{l_0}{3}$

$$v = c \cdot \sqrt{1 - \frac{L^2}{L_0^2}} \Rightarrow v = c \cdot \sqrt{1 - \frac{\frac{l_0^2}{9}}{l_0^2}} \Rightarrow v = c \cdot \sqrt{1 - \frac{1}{9}}$$

$$v = c \cdot \sqrt{\frac{8}{9}} = \frac{2}{3}\sqrt{2} \cdot c = 0{,}943 \cdot c \Rightarrow v = 2{,}83\,10^8 \frac{m}{s}$$

(9) $t_0 = 1{,}000\,s$ $\quad \Delta t = \gamma \Delta t_0$ $\quad \gamma = \frac{1}{\sqrt{1 - 0{,}8^2}} = 1{,}67$

$$\Delta t = \gamma \cdot \Delta t_0 = 1{,}67 \cdot 1{,}000 = 1{,}675.$$