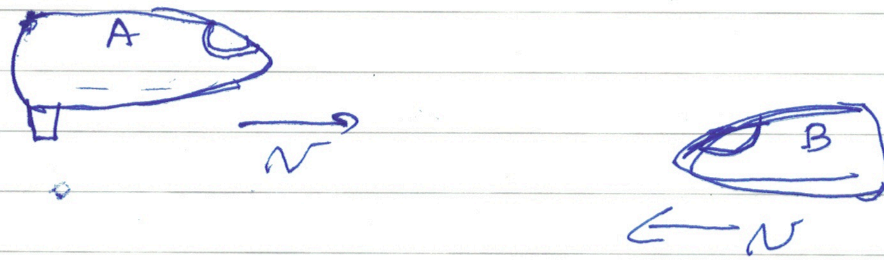
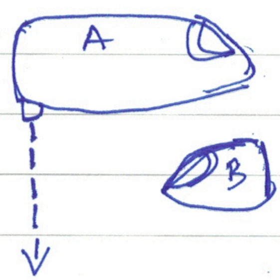
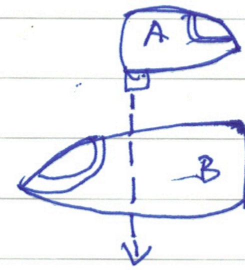
Típica paradoja



(i)

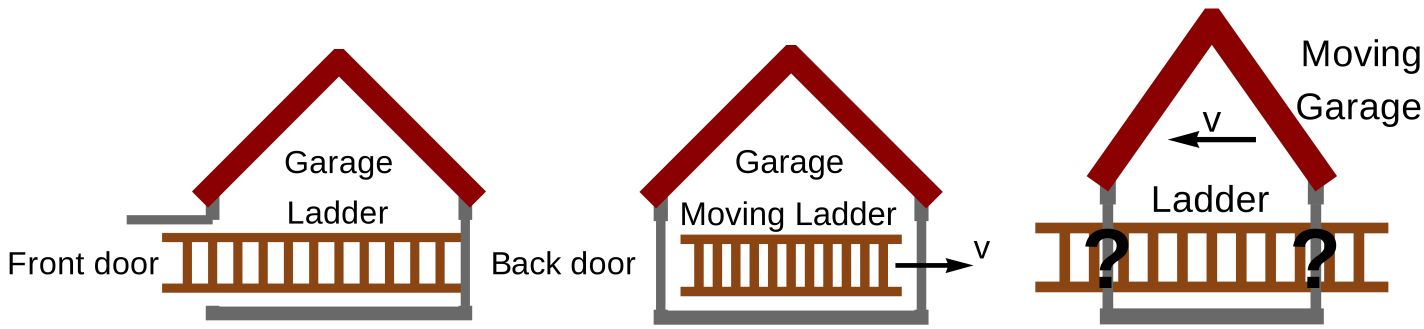


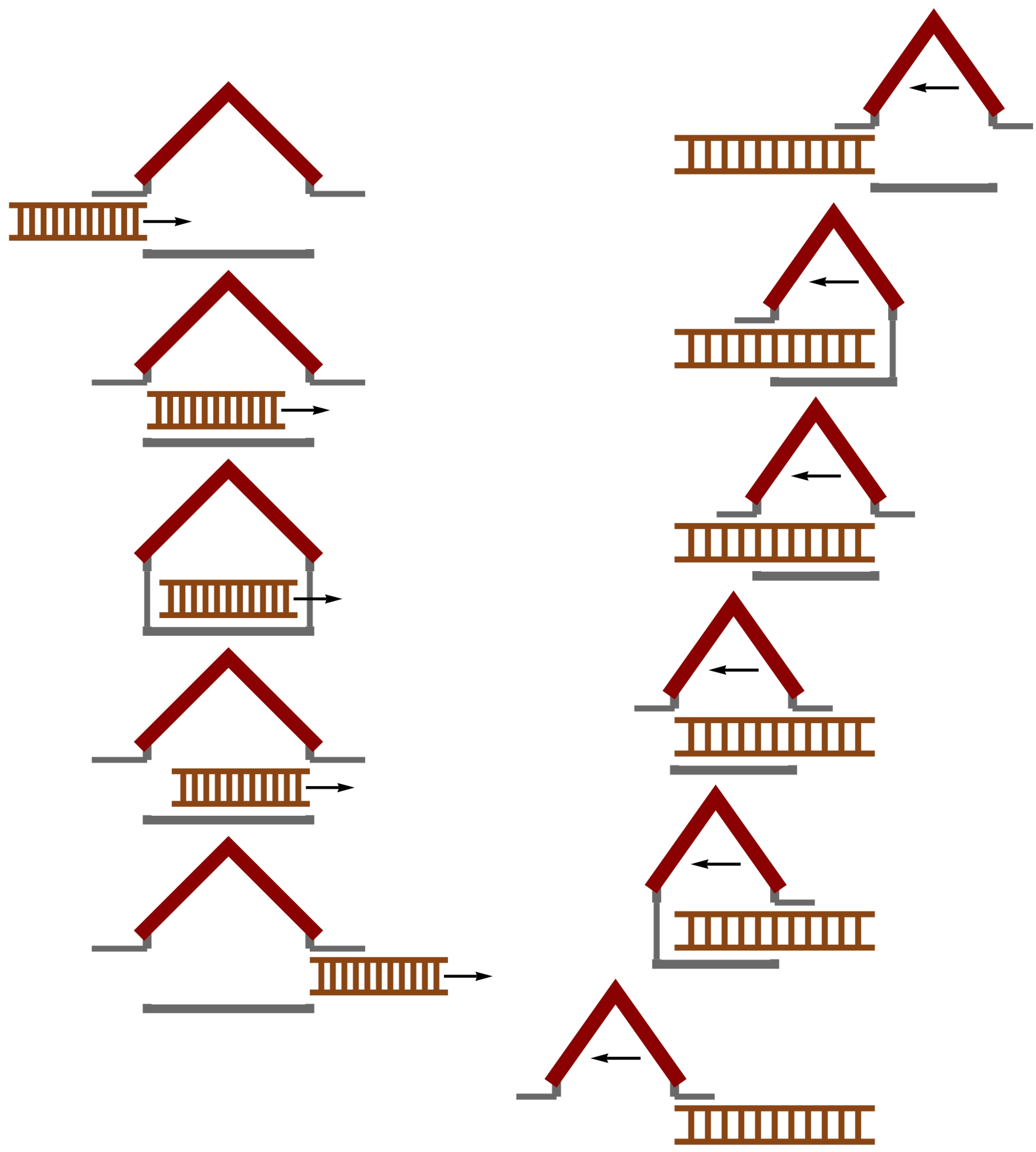
(ii)



ES DESTRUIDA LA NAVE B ?

Paradoja de la escalera





Simultaneidad !

composición de velocidades

$$u_n = \frac{u_{n+1} + v}{1 + \frac{u_{n+1} v}{c^2}}$$

para $n \to \infty$, $u_n \to u$, $u_{n+1} \to u$

$$u = \frac{u + v}{1 + \frac{uv}{c^2}} \Rightarrow u\left(1 + \frac{uv}{c^2}\right) = u + v$$

$$\frac{u^2 v}{c^2} = v \Rightarrow u^2 = c^2$$

$$\boxed{u \to c}$$

Muons

$$N(t) = N_0 e^{-t/\tau}$$

τ = vida media $\simeq 2\mu s$ (sist. reposo c/r al muón)
$v \simeq 0.998c$ y son creados en la alta atmosfera.

La distancia recorrida (desde S) debería ser $h \simeq v\tau = 0.998c \cdot 2\mu s = 600$ m.

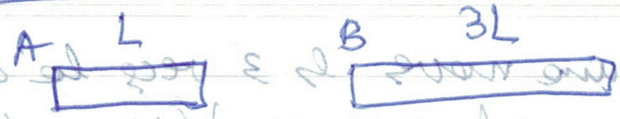
Desde la tierra, $\tau \to \gamma\tau \simeq 15 \times 2\mu s = 30\mu s$

$\Rightarrow h \simeq 9.000$ m

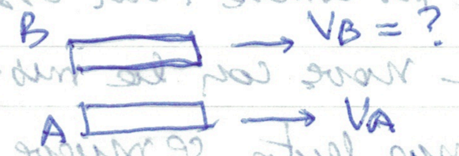
Desde el muón, τ no cambió, pero el suelo se aproxima a $0.998c$ $\Rightarrow$ se contrae la altura y $9000\,m \to \dfrac{9000\,m}{\gamma} = \dfrac{9000}{15} = 600$ m.

$\therefore$ El muón llega al suelo ya sea analizado desde S ó S'.

Prob. 26 (Serway) $\rightarrow$



The proper length of one spaceship is three times that of another. The two spaceships are traveling in the same direction and, while both are passing overhead, an Earth observer measures the two spaceships to have the same length. If the slower spaceship is moving with a speed of 0.35c, determine the speed of the faster spaceship.



(S) ∴ $L_A = \dfrac{L}{\gamma_A}$

$$L_B = \frac{3L}{\gamma_B}$$

but $L_A = L_B \Rightarrow 1 = \dfrac{\frac{L}{\gamma_A}}{\frac{3L}{\gamma_B}} = \dfrac{\cancel{L}\gamma_B}{\gamma_A \cdot 3\cancel{L}} = \dfrac{\gamma_B}{3\gamma_A}$

$$\Rightarrow \gamma_B = 3\gamma_A \Rightarrow \frac{1}{\gamma_B} = \frac{1}{3\gamma_A} \Rightarrow \sqrt{1-\left(\frac{V_B}{c}\right)^2} = \frac{1}{3}\sqrt{1-\left(\frac{V_A}{c}\right)^2}$$

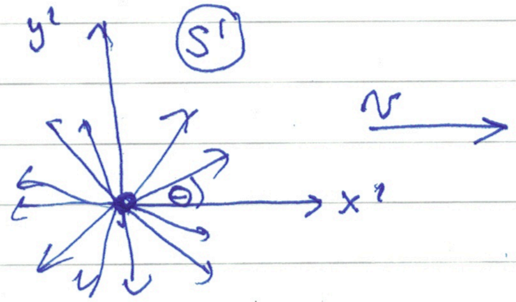
$$1 - \left(\frac{V_B}{c}\right)^2 = \frac{1}{9}\left(1 - \left(\frac{V_A}{c}\right)^2\right) = \frac{1}{9} - \frac{1}{9}\left(\frac{V_A}{c}\right)^2$$

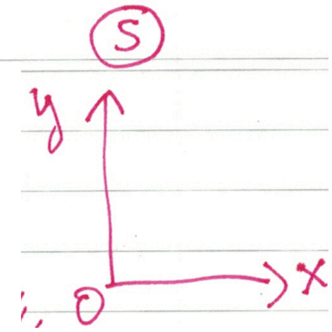
$$\frac{8}{9} - \left(\frac{V_B}{c}\right)^2 = -\frac{1}{9}\left(\frac{V_A}{c}\right)^2 \Rightarrow \left(\frac{V_B}{c}\right)^2 = \frac{8}{9} + \frac{1}{9}\left(\frac{V_A}{c}\right)^2$$

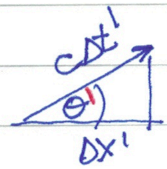
$$\frac{V_B}{c} = \sqrt{\frac{8}{9} + \frac{1}{9}\left(\frac{V_A}{c}\right)^2} < 1$$

$$= 0.95$$

Haces de luz







$$\cos\theta' = \frac{\Delta x'}{c\Delta t'}$$

$$\cos\theta = \frac{\Delta x}{c\Delta t}$$

$$\cos\theta = \frac{\Delta x}{c\Delta t} = \frac{\gamma(\Delta x' + v\Delta t')}{c\gamma(\Delta t' + \frac{v}{c^2}\Delta x')} = \frac{\left(\frac{\Delta x'}{\Delta t'}\right) + v}{c\left(1 + \frac{v}{c^2}\frac{\Delta x'}{\Delta t'}\right)}$$

$$= \frac{\frac{\Delta x'}{c\Delta t'} + \frac{v}{c}}{1 + \frac{v}{c}\frac{\Delta x'}{c\Delta t'}} = \frac{\cos\theta' + v/c}{1 + \left(\frac{v}{c}\right)\cos\theta'}$$

$$\boxed{\cos\theta = \frac{\cos\theta' + \beta}{1 + \beta\cos\theta'}}$$